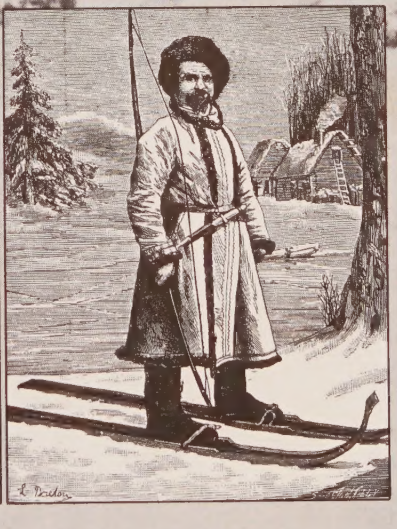
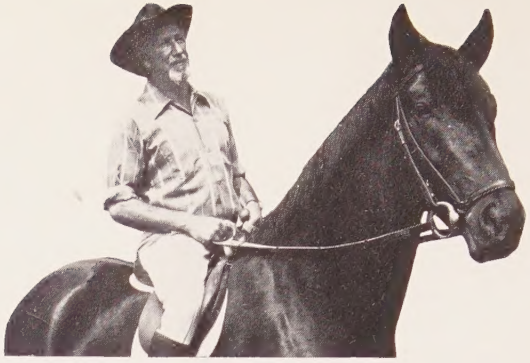
# Snow travel and transport

## The story of snowmobility in pictures



Walter Lorch



# The author

Walter Lorch climbs things because they are there and invents things because they are not.

Born in Germany in 1914, he soon developed a belief in personal freedom and non-conformity. The rise of Hitler threatened such a life style and he interrupted his electrical engineering apprenticeship and, in 1935 arrived in England, which has been his home ever since.

In 1940 he joined REME, in due course volunteering for the 6th Airborne Division which promised greater scope for individuality than most sections of the armed forces. For some time he was attached to the winter warfare training establishment as ski-ing instructor. Emerging into peace with the rank of sergeant he returned to work in the field of water treatment.

His invention—the cartridge-type deionizer—has superseded the classical process of distillation and is used worldwide. Part of the earnings of his family business go to The Lorch Foundation whose aim is to encourage original thought and common sense in all fields of human endeavour. In 1972 Walter Lorch relinquished the Chair to spend most of his time at The Muschamp Stud, Fulmer which he and his wife had established in 1960. There he proved a personal theory—that England needed a new breed, a blend of the English Thoroughbred and the East Prussian Trakehner. The result was the Anglo-Trakehner, now well known all over the world for its temperament, performance and reliability.

Veteran and vintage cars have also claimed a generous share of Walter Lorch's time and enthusiasm. He covers many miles in his 1915 Model 'T' Ford on which his son Robert passed his driving test at the age of 17. Last year he travelled to Istanbul through Central Europe in his 1927 Chrysler, covering some 13 000 km with only eight-and-a-half hours maintenance.

His devotion to ski-mountaineering has not declined with the years and he has negotiated many European peaks. Asked by the Alpine Ski Club, of which he is currently vice-president, to evaluate electronic avalanche search devices, he brought to this task a very real experience coupled with the grasp of the technical problems involved. As a result small pocket transceivers are now available to ski mountaineers, presenting a significant advance in mountain safety.

This book, which is a culmination of a lifetime's fascination with snow travel, a subject which has never before been properly documented, typifies Walter Lorch's obsession with breaking new ground.

# About the book

Walter Lorch has broken new ground in his search to tell the story of transportation on snow and ice. "Snow Travel and Transport" is uniquely comprehensive and covers every aspect of this fascinating subject with the help of a quite remarkable collection of some 200 illustrations. This is a book for the connoisseur and casual browser alike and a must for the library of every skier, alpinist and transport enthusiast.

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# Snow travel and transport

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# Snow travel and transport

## The story of snowmobility in pictures

Walter Lorch

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*In memory of*
*Walter Sporrer*

# Acknowledgements

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Dr Karl Nickul provided the background to life in Lapland, and Lauri Santasalo translated vital information from the Finnish. Rosemary le Fleming's rare books on the Trans-Siberian Railway highlighted this chapter and Alexander Kuznetsov's sketches clarified Russian sledge construction. Elaine Styles succeeded in providing sparkling copies from faded originals. Rex Bunny provided the expertise on horse driving and harnessing. Dr Erik Bühler contributed much to the air rescue scene and Mme Hilda Geiger's photos from her late husband's unique collection brought this chapter to life. Ydde Ecnérval's superb diagrams are in themselves a record of snowmobility. June Austin typed and re-typed the manuscript and never grumbled; Elisabeth Moreau did the proof-reading in record time. My wife Diana acted as chief sleuth and was instrumental in bringing the book to the shelves.

# Contents


| | Page | Illustrations |
|---|---|---|
| Acknowledgements | 5 | |
| Illustrations | 9 | |
| Introduction | 13 | |
| Snow shoe and ski | 15 | 1–14 |
| Man power | 23 | 15–25 |
| Animal power | 29 | 26–31 |
| Reindeer | 33 | 32–52 |
| Dog | 45 | 53–64 |
| Horse | 51 | 65–89 |
| Rails on ice and snow | 63 | 90–106 |
| Extreme north and south | 73 | 107–134 |
| Motor power | 89 | 135–155 |
| Chains and ploughs, tyres and blowers | 101 | 156–175 |
| Ski-planes and rescue | 111 | 176–202 |
| War | 125 | 203–218 |
| The horseless sledge | 135 | 219–237 |
| Snowmobility | 145 | |
| Plates I–VI | 147 | |
| Bibliography | 153 | |
| Photocredits | 155 | |
| Index | 157 | |
| Maps | End paper | |

# Illustrations


**Snow shoes and ski**

1 The earliest skier
2 Snow shoes for man and horse
3 Reindeer hunt, Lapland
4 Samoyed hunters
5 Samoyed hunters
6 Votiak of Northern Siberia
7 Japanese climber
8 Lapp traveller
9 Postman in the French Landes
10 Mail delivery, Switzerland
11 Parcel service, Switzerland
12 Express delivery, Switzerland
13 Snow and ice bicycle
14 Snow-velo, Switzerland

**Man power**

15 Samoyed sledge
16 Mongol caravan, Tibet
17 Ice sledge, Bavaria
18 Ice ferry, South Germany
19 Improvised sledge, London, England
20 Ceremonial sledge, China
21 Ice sledge, China
22 Collapsible sledge, South Germany
23 Dual purpose sledge, Austria
24 Beer transport sledge, Holland
25 Water transport, Lapland

**Animal power**

26 Ox sledge, New Brunswick, Canada
27 Yak caravan, Tibet
28 Camel transport, Siberia
29
30 Ox sledge, Caucasus, USSR
31

**Reindeer**

32 Ski-jöring, Scandinavia
33 Lapp hunters
34 Boat sledge, Lapland
35 Samoyed reindeer troika
36 Reindeer transport, Lapland
37 Reindeer food store
38 Reindeer herders at camp
39
40 Transport to winter village
41
42 Sledge maintenance
43 The Czar with team of three
44
45 Move from the winter village
46
47 Lapp families on the move
48
49 Making a Pulkha
50 Making a Komi-type sledge
51 Reindeer mail
52 District nurse, Lapland

**Dog**

53 Dog sledge, North Siberia
54 Skin sledge, North America
55 Komatik and dog team
56 Dog team, fan hitch
57 Large komatik
58 Huskies in double tandem
59 Built-up sledge, Alaskan Highway
60 Single tandem harness
61 Trapper, Alaskan Highway

62 Plane and dog
63 Malamutes
64 Status transport

**Horse**

65 Horse sledge 1648
66 Bavarian sledge
67 Siberian sledge
68 St Petersburg omnibus
69 Troika taxi
70 Troika
71 The snow storm
72 Canadian mail
73 Swiss mail
74 Snowdrift tunnel
75 Swiss bus with trailer
76 The Liverpool mail, England
77 New York camion
78 New York passenger transport
79 Training to sledge harness
80 Breaking-in, Scotland
81 Status transport
82 The Royal sledge, England
83 Royal two-in-hand, London
84 New York traffic
85 Sledging in Stockholm, Sweden
86 Four-in-hand, Quebec, Canada
87 Caribou hunting, Canada
88 Ice-fishing, Canada
89 Donkey sledge, Mürren, Switzerland

**Rails on ice and snow**

90 Permafrost stratum
91 Trans-Siberian rail construction
92 'Provisional' traffic
93 Permafrost laboratory, Siberia
94 The Baikal trainferry
95 The Angara icebreaker
96 Horse sledges on Lake Baikal
97 Caterpillar track layer
98 Tanker train, Eastern Siberia
99 Snow-plough in Canada
100 Line blocked, Scotland
101 Giant snow-plough, Sweden
102 Derailment in snowdrift
103 Early snow-thrower
104 Modern snow-thrower
105 Snow-thrower in action, Switzerland
106 Bernina Line, Switzerland

**Extreme North and South**

107 Sail and kite sledges, Melville Island
108 Two-runner sledge, Schwatka Expedition
109 Poster for Shackleton's South Pole Expedition
110 Shackleton's Arrol-Johnston
111 Prototype wheels
112 The Arrol-Johnston en route to the Pole
113 Maize crusher and the Arrol-Johnston
114 Motor hauling
115 Return journey
116 Propeller sledge
117 Propeller sledges in Antarctic
118 Shackleton's motor tractor
119 Captain Scott's snow-tractor
120 Early trials of Wolseley tractors
121 Wolseley tractors for shipment

122 Sir Vivian Fuchs' Snocat display
123 Snocat train
124 Crossing Antarctica
125 Crevasse hazard
126 Ferguson tractor with radio caboose
127
128 British Antarctic Survey's Muskegs
129 'International Harvester' tractor
130 The Gnat
131 Supply ship, Antarctica
132 RRS *John Biscoe*
133 Atomic icebreaker
134 Man power

**Motor power**

135 Tramway sledge, Dresden, Germany
136 Motor sledge inventions
137 Count de Lissek's propeller sledge
138 Paddle wheel sledge, Germany
139 Snowtractor, Chamonix, France
140
141 Rolland-Pillain motor sledge
142 Nivert propeller sledge
143
144 de Bosse dual-purpose car
145
146
147 Clerget propeller car
148 Legrain propeller sledge
149 Grand Duke Cyril's turbine sledge
150 Horner's caterpillar sledge
151 Scania-Vabis post bus
152 Saurer bus with Nyberg traction
153 Citroën half-track winter sportscar
154 Postal bus with snowplough
155 Double decker bus, London

**Chains and ploughs**

156
157 Snow chain advertisements
158
159 Snow chains on test
160 Horse-drawn snowplough, London
161 Improvised snow clearing, London
162 Gas-turbine snow blower, Canada
163
164 High altitude snow clearing, USSR
165 Snow blower in the Alps
166 Snowed-up, Sakhalinsk, USSR
167 Archimedes screw principle
168 Blizzard at Sakhalin, USSR
169
170 Snow clearance, Moscow, USSR
171 Snow melter, USA
172 Domestic snow clearance
173
174 Snow tyres
175 Road clear, Switzerland

**Ski-planes and rescue**

176 Grandjean's ski-plane
177 Glacier pilot Hermann Geiger
178 Glacier landing
179 Short landing technique
180 Short run take-off technique
181 Sheldon's ski-plane, Alaska, USA
182 Conso aircraft, South Shetland, Great Britain

183
184 Air rescue—man and dog
185 Ski-plane and dog team
186 Fuel delivery by helicopter
187
188 Power line construction
189 Air rescue helicopter
190 Avalanche dog in action
191
192 Ski-plane rescue
193 Air rescue hammock
194
195 Ambulance helicopter
196
197 Helicopter operating theatre
198 Flying doctor service
199
200
201 Evacuation of Farmer Florian Iten
202

**War**

203 Ski stretcher, Russia
204 Artillery sledges, Norway
205 Sledges awaiting the Kaiser's offensive
206 Evacuation of the wounded
207 Air sledge for the Kaiser's army
208 Military two-in-hand
209 Improvised transport for wounded. Second world war
210 Canadian infantry with snow shoes
211
212 Swiss ski troops
213 Ski-borne
214 Alpine mule train
215 Bombardier troop carrier
216 Air-propelled skier
217 Amphibious propeller sledge, USSR
218 Canadian ski-troops

**The horseless sledge**

219 Snocats in icefield, Alberta, Canada
220 Tractor-train, Antarctica
221 Bombardier first snowmobile
222 Bombardier Model T snowmobile
223 Bombardier snowmobile, early thirties
224 Bombardier sprockets traction unit, 1935
225 Bombardier snowmobile bus
226 Passenger service, Siberia
227 Snow-truck and dog sledges
228 Proviant delivery, Russian Lapland
229 Gas trunk line operations, Siberia
230 The driver
231 Russian Ski-doo
232 Ski-doo at speed
233 To the trading post
234 Hauling winter fuel
235 Feeding cattle
236 Amphibian air sledge, USSR
237 Tomorrow's snow transport?

Plate I Snow shoes and antique sledges
II Eskimo and Lapp sledges
III Built-up sledges
IV Dog teams and harness
V Horses and harness
VI Gun transport and motor sledges

# Introduction

by

Lord Montagu of Beaulieu

Man is for ever seeking new worlds to conquer; in no aspect of civilization is this outward urge so apparent as in the realm of transportation. From the harnessing of animal power he has progressed to more sophisticated mechanical methods. These have in turn been applied to travel on land, to the crossing of the sea, to the air and, in more recent years, to the exploration of space.

All these aspects of the story have been comprehensively documented but little attention has been paid to a problem much nearer at hand, yet only recently mastered by the combination of man and machine: communications in those parts of Earth where snow and ice inhibit the construction of orthodox roads or railways.

From earliest times inhabitants of the colder latitudes have faced special difficulties. Reindeer and dog teams harnessed to sledges took the place of the horse, the ox and the wheeled cart. With the advent of mechanized transport, the railway pioneers were faced with the task of bringing the permanent way to such places as Central Siberia, where winter temperatures can fall below minus 40°C.

The last years of the nineteenth century brought with them the internal combustion engine. Though it would be some time before this new locomotion was reliable even under normal operating conditions, by 1912 such explorers as Shackleton, Charcot and Scott had sought to apply it to Polar use; the two latter, indeed, utilized motor-sledges.

These pioneers ran into such problems as traction on slippery surfaces and the effect of sub-zero temperatures on cooling systems. Air cooling was only part of the answer; the next step came with warbred and semi- and full-track machinery, notably the Citroën-Kégresse, brainchild of a former superintendent of the Czar's garages. Thence it was a logical progression to the advanced Snocats used in the Antarctic in 1957 by Sir Vivian Fuchs.

By the 1970s a whole army of lightweight machines had superseded dog, reindeer and horse in the cold regions.

Aircraft had long been produced with interchangeable wheel, float or ski landing gear and alongside the ski-planes and half-tracks there evolved a generation of ski-cum-track devices, the snowmobiles. In

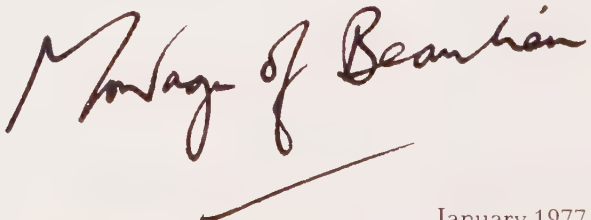
Northern Canada these served as the Fords and Chevrolets of the long winter, being used as taxis, school buses, mail vans and even hearses.

A more general need was, of course, that of keeping roads open wherever possible. As late as 1929 many a Canadian motorist was resigned to a winter lay-up. Snow chains had been in use as early as 1904 but with the spread of motoring came the snow tyre and chemical anti-freeze. Road maintenance grew more specialized, with snow-ploughs, snowblowers and mechanized gritters which replaced the once familiar workman with his shovel, perched frigidly on the back of a truck.

Here at least is an attempt to collate the story of transportation on snow and ice, as opposed to mere winter sport or exploration in its basic form. Every aspect is covered from war to rescue work in the cold latitudes, utilizing aeroplanes and helicopters where landborne vehicles cannot go.

It is a story of personal interest to myself, in that my father was closely associated with the first of all the serious polar motor vehicles, built for Ernest Shackleton in 1907 by Arrol-Johnston of Scotland. This one was only a qualified success, but even then the industry was thinking in terms of snow melters in the exhaust system, non-freezing lubricants (which seem to have worked) and wooden tyres (which did not).

It is apposite that this book should have been written by a man of wide interests. Walter Lorch not only breeds horses; he is also often to be seen at the wheel of a brass-radiatored Model-T Ford, perhaps the most versatile car of all times and one that was frequently encountered on skis or tracks in the northern latitudes. I wish the book every success.



January 1977

# Snow shoe and ski

The snow shoe is the first mechanical aid to surface travel for man. Contrary to the wheel, whose prime function is the movement of goods, the snow shoe serves man only where true winter conditions prevail. Its purpose: to prevent the wearer from sinking in by distribution of his weight over a larger area and, in the more advanced designs, to permit gliding over the snow at speed. In this sense the term includes the ski, which is simply a more sophisticated and faster model of the snow shoe. Both have played a vital role in northern communities by keeping men fed, clothed and protected against foe.

Three basic methods of construction are found in all regions: the frame or basket type, the wood plank type—both come in the bearpaw or pointed heel form—and the wood-ladder type, which appears only in Lapland. Siberian tribes use a unique boatshape version, with front and rear pointed up for speed. (Plate I). A woodcut of nineteenth-century Japan shows the unusual combination of a walking stick with the snow shoe, presumably for balance and to facilitate climbing. Conversely, the Eskimo introduced the snow shoe only in recent times and are the only northern people to evolve without it.

Travel speed: for the basic snow shoe between 2 km/h in deep soft snow and 7 km/h on compacted surfaces. Snow shoes for horses are still used in Labrador, Canada for the transport of cargo from isolated villages to ports where no made-up roads exist. Today's cross country (Langlauf) ski permits nonsporting travel at 6–30 km/h depending mainly on the territory's contours. Skis have remained an important means of travel and communication in the less populated areas of the Alps and Scandinavia. School children with their satchels and the postman are a common sight on skis. In mountain and avalanche rescue, or in war, for food distribution to snowed-in man and animal, and for medical first aid, the ski reigns supreme.

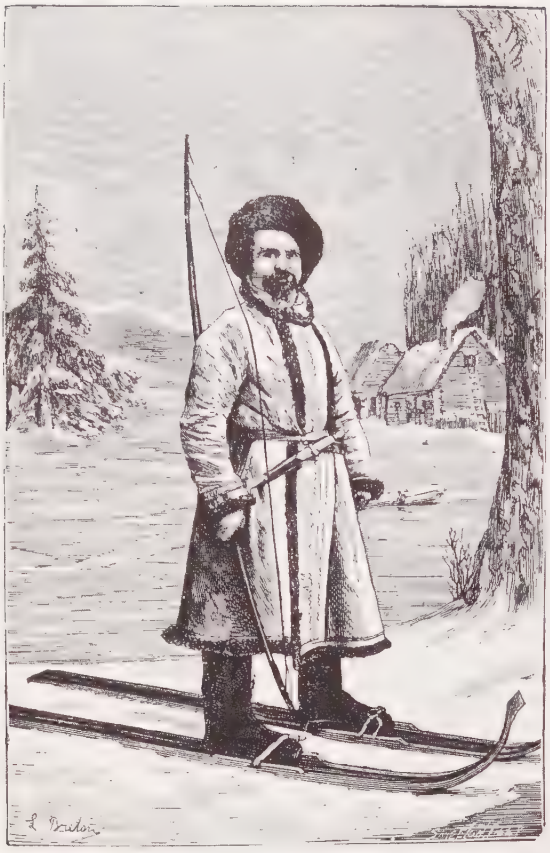
It is striking that the earliest historical evidence—a carving of 'The Rödöy Man' on a rockface in North Norway in the Arctic Circle—depicts a man on skis and not on snow shoes; it was found in 1930 and dated from the stone age. Archaeological finds of reasonably preserved wooden sections from Northern Europe clearly point to skis dating back to the time of Pharaoh. Very little proof exists from antiquity, either in the form of carvings or through archaeological finds, pointing conclusively to the simple snow shoe. It was obviously too dull to draw. The ski has speed and grace. My earliest graphic presentation is a woodcut in Olaus Magnus' Carta Marina of 1539 of man and horse fitted with snow shoes for marshland and snow travel.

The earliest skier. Rockface carving from the stone age—2000 BC. It was discovered in 1930 near the Arctic Circle in the North of Norway. On all rock drawings of prehistoric times the human figure always appears in profile. Sometimes elk or reindeer are shown being hunted by men on skis. *1*

Snow shoe for man and horse. Scandinavian woodcut, sixteenth century. *2*

Reindeer hunt on snow shoes in Lapland. Skiers will note with fascination the Vorlage position of the hunter on the left in this seventeenth-century woodcut. *3*

Samoyed moving on boat-type snow shoes *ca* 1830 (Plate I). Native to Siberia and living exclusively by reindeer breeding, hunting and fishing, their travels stretch over the huge expanse of two continents. Their language covers forty distinct dialects. The majority are Yurak and lead a nomadic life on the tundras between Archangel and the mouth of the river Yenisey. Toward the east are the Yenisey and Avam-Samoyed, also nomads and rapidly dwindling in numbers. The Ostyak have their home in the tundras between the Ob and Yenisey rivers. Much further south, toward the high Sayan mountains, live a very small remainder of the Kkamassin tribe. *4 and 5*



A Votiak of Northern Siberia, 1889. ' . . . he had a red beard and hat under a thick shabby fur cap, over his shoulder were slung a long bow and some arrows and on his feet—skis. I watched this Votiak disappear gradually among the trees like a spirit of the forest, careless of the rifts over which he passed without seeming to notice them.' *6*

Climber on snow shoes. Japanese woodcut, nineteenth century. *7*

Traveller in Lapland, 1938, on a rather broad cross-country ski 2·45 m long. The exceptional width and length point to work in very soft snow. *8*

Winter in the French Landes. The most eccentric snow shoes. Between Bordeaux and Bayonne lies that stretch of country known as Les Landes. A great part of this land—formerly waste land—has been reclaimed and planted with pine trees for resin extraction. Large areas, however, remain wild moor, covered with gorse and broom. Villages and farms are widely scattered. To traverse these wide plains with ease, the inhabitants used stilts tied to their legs; mounted on these the shepherds watched their flocks and could cross pools, marshes and peat without difficulty. They carried a long pole for support when resting. The postman too, employed these stilts for his job. In winter time when Les Landes are covered with snow the stilts are fitted with wooden snow shoes of the pointed heel and toe version. The modification enables them to walk or even glide over the snow without sinking. The postman is clad in a white cloak—*le capot*—lined with sheepskin, complete with hood; his legs are covered with sheepskin gaiters. *9*

In the European Alps and Lapland, the postman prefers skis to do his rounds and to this day the ski has proved the fastest and most economical way to deliver mail and parcels in areas of widely-separated houses.

Mail delivery, Swiss Alps, 1963. *10*

Parcel service. Arosa, Switzerland, 1930. The view to the Hörnli is, as yet, unspoiled by skilift cables. *11*

Express delivery, Grindelwald, Switzerland, 1936. *12*

The snow and ice bicycle is a German invention of 1896 and anticipates the basic approach of the automobile designer to improve handling and traction on snow. The front wheel is replaced by a ski; the rear wheel is covered by a band fitted with metal spikes for good grip. A contemporary 'road test' states: 'on hard-ridden snow-covered roads the new machine runs at the usual speed, but on ice it seems to fly along with very little exertion on the part of the rider. A similar machine is in use on the great Canadian Lakes.' *13*

A more practical version is this Swiss Snow-Velo, still in regular use for mail distribution in Swiss Alpine regions. Grindelwald, Switzerland, 1952. *14*

# Man power

Encyclopaedic definitions of the word sledge refer to the travoise of the North American Indian as the basis for sledge development and in the History of Transport section, *Encyclopaedia Britannica* states: '. . . the earliest agricultural workers probably shifted hay on the forked branch of a tree . . . From this developed the "Y"-shaped sledge or travoise used in more recent times by North American Indians. The travoise was two poles tied together with the "V" resting on the back of a man or animal. Between the poles was slung a wooden or net frame. The "Y" sledge was widely used in Northern Europe and throughout the cattle regions of Africa.' I think this explanation is misleading: today's common usage of the term 'sledge' refers to a vehicle designed specifically for use on snow. I can find no evidence that the travoise is either suitable or indeed has been developed for traversing snow or ice. I would, therefore, recommend lexicologists to define this as a land sledge and to restrict the word sledge to snow and ice vehicles.

Among prehistoric finds in the north is a keel of a sledge and remains of runners which Dr Erik Granlund of Sweden's Geological Survey assigns to the younger stone age. Similar sledge runners were discovered in Sweden and Finland belonging to the bronze age. Their reconstruction suggests that they were between 1·20 m—4·50 m long and the position of vertical and horizontal holes points clearly to the single runner hunting or boat sledge. (Plate I). One or two bog finds indicate the use of two-runner sledges, the platform being fixed to the runners by strips of skin. According to Göster Berg, hunting sledges were also made from hollowed tree trunks and, without exception, front and often rear had provision for a single dragline. There is also evidence that guide runners were used. These were made from wood in the shape of a ski but very much heavier and less elastic. The load was centralized and strapped to the runner. Personal belongings were carried in the skin sledge. (Plate I). Animal skin, for the conveyance of man and goods over marsh, bogland and snow, has probably been used long before recorded history. In 1555 Olaus Magnus writes in *Historia om de Nordiska Folken*: '. . . an elderly man who wishes to be conveyed down a steep mountain side or a hill must seat himself on a bear skin and be trailed along by the aid of his sons or serfs . . . '. There is no cultural analogy in England until the advent of the polythene sheet, now used quite often to move grass cuttings after mowing instead of the wheelbarrow. Secondary dictionary definitions of the word sledge, sled or sleigh include: . . . 'transport for those to be humiliated or the condemned'. There are historical reports of Jews being dragged to the place of public punishment on a cow hide and of prisoners being so conveyed to the gallows.

Samoyed hunters with sledge awaiting the day's haul. The oblong basket carries seal or fish and the towline clearly indicates man-hauling. Runners are curved equally at both ends to facilitate handling and change of direction. *15*

Man is disinclined to use himself as a draught animal and where economy forces him to do so he represents the lowest strata of society. There are exceptions: where conditions become impossible for beast or motor, man takes over. Love, courtesy and respect are the other important motives. Man carries his new spouse over the threshold of their joint home. The charming Bavarian in the flowing cloak conveys his girl friend across the Tegernsee on a sledge; father pushes his children on a typically English improvisation over the frozen Thames.

Caravan in Tibet. *16*

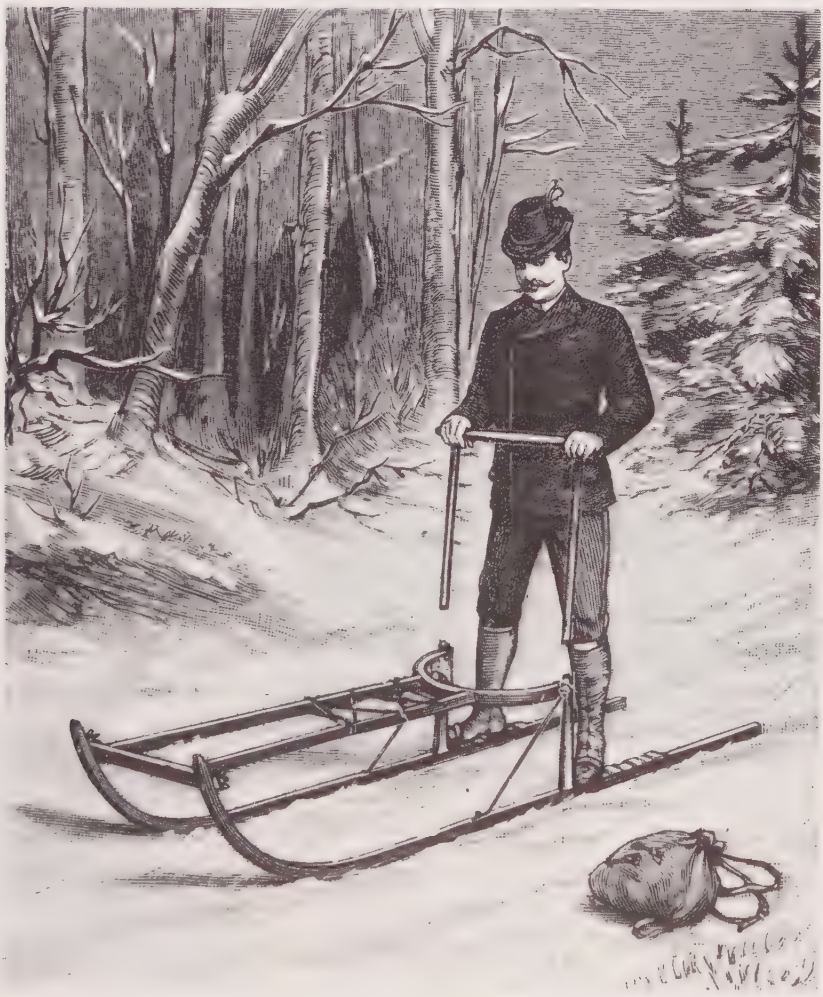
Ice sledge on the Tegernsee, Bavaria, Germany. In the background a man crosses over on a unique ice scooter. Eighteenth-century engraving. *17*

Ice ferry moved by punting pole. Königsee, South Germany, 1931. *18*

Chair and case lid make an ideal sledge on the rare occasion of a real English winter. Father braves the cold in his usual bowler hat and suit—no coat or gloves. No doubt case lid and chair will revert to their normal function after the frost. The frozen Thames, London, 1881. *19*

Emperor of China on the move, hauled by a team of eight. *20*

Westerner on improvised sledge in China, driven gondolier fashion, 1913. *21*



Collapsible sledge for conveyance of man or goods, based on the Canadian ice sledge. In common use in alpine countries where terrain permits, the driver stands on the back and propels sledge with one foot like a scooter, 1894. *22*

Dual purpose vehicle. Austria, early twentieth century. *23*

Beer transport over frozen canal. Holland, 1917. *24*

Suenjel girl bringing water to the winter quarters from a hole in the ice. Lapland, 1934. *25*

# Animal power

Archaeological evidence suggests that cattle were domesticated, in their natural habitat, as far back as 9000 BC and reindeer formed part of the family life in the Arctic and sub-Arctic not much later. Yet a further 5 000 years had to pass before humans thought of their potential for carrying and pulling loads. Oxen drew land sledges in Mesopotamia before 3500 BC but I found no records of their prehistoric use in winter.

Lumbering in New Brunswick. Oxen at work in the forest, 1858. *26*

Caravan on the move in High-Asia with yaks and mules used to carry men and goods. The yak—native of North Tibet—is at home in high altitudes and can work at heights of 5 000 m. On the cold plateaux of Tibet and the neighbouring provinces of China, as well as on the southern slopes of the Himalayas, the yak is the principal beast of burden. *27*

A winter market day at Omsk, Siberia. *28*

These photos were taken in Svanetia, a remote mountain area in the Caucasus, USSR in 1973. The ox and the cow pull a dual-purpose sledge identical in design and construction to the bronze age models. The tower is part of every house in this region of bitter blood feuds. *29, 30 and 31*

# Reindeer

In Lapland, Finland, Greenland, Spitzbergen and Siberia the reindeer has been used as a pack and draught animal for centuries. This is confirmed by archaeological finds in ritual graves where harness and reindeer bones were buried next to man. A breed related to the reindeer—the caribou—common in Eskimo regions of Canada and North America has not been domesticated and is still hunted today. In Siberia, however, a larger type of reindeer has been ridden for hunting.

This early Scandinavian travels on skis pulled by a reindeer. He used the Hari for balance and braking. In the thirties ski-jöring behind horses was a fashionable sport in the European Alps and race meetings take place in winter resorts even today. *32*

## Lapps & Samoyed

There is a close cultural bond between Lapps and reindeer: originally this ancient race was truly nomadic, following the migrations of the reindeer between summer and winter ranges. Today these people—without a state of their own—live in territory allotted to them by their countries—Sweden, Norway, Finland and USSR. They may be divided into four groups: the Forest, River, Coast and Reindeer or Mountain Lapps. The last sect are still true nomads, depending entirely on reindeer and migrating considerable distances with their herds. Their reindeer husbandry is a recent advance, but they depend on hunting and fishing, traditionally of Arctic-Siberian character. With reindeer power came increased speed and the need to redesign the old sledge originally intended for man-hauling. To this day, however, many of the ancient single runner designs remain in daily use; the same applies to harness where the single trace rope of the man-powered sledge is still common for the boat sledge and where load and speed are moderate. (Plate II).

Lapp hunters in action. They are dressed in bear skin. The contemplating man carries a stone for sharpening weapons and keys which indicate huts at the winter village. The single runner boat sledge has two skin traces leading between the legs to a single point fixing on the galloping animal's collar. The driver holds the reins in his right hand and uses the Hari for balance. Seventeenth century. *33*

Young Lapp paterfamilias ready to leave for work. The scene has a familiar ring when mentally we replace the reindeer with a Volvo, the gun with a briefcase but leave the antlers intact as the radiator mascot. And we all know the wife. The single rope trace attached to the reindeer's collar survives from the man-hauled sledge. Lapland *ca* 1850. *34*

Samoyed reindeer troika on a visit to St Petersburg. Contrary to the Lapps, the Siberian tribes drive as a rule a team of three. As they always drive the left animal, the reins are held in the left hand. The Hari is used to increase speed and a gentle tap on the left or right is the signal for a change of direction. The single rein attached to the left antler is the 'brake'. (Plate III). *35*

Lapps in Oulu, Market Day, 1880. *36*

Reindeer herdsman climbing up to the Njöll—a food store, 1913. *37*

Men of the Mountain or Reindeer tribe at the camp fire, 1913. *38*

Preparing for the move to the winter village, 1934. The wild reindeer live on grass in the summer and lichen or reindeer moss in winter, which they reach by scraping the snow with their hoofs. Here lichen and hay are taken to the winter quarters. The compact and light load of lichen travels in the pulkha, the traditional Lapp boat sledge. Hay is transported on a modified Rislareki; it is equipped with shafts, fitted always at the lowest point of gravity. Shafts are used for heavy loads: in conjunction with suitable harness, they stop the sledge from gliding into the reindeer on slowing down. The third sledge—again provided with removable shafts—carries wood for fuel. (Plate III). *39, 40 and 41*

Young Lapp woman re-tyres the runners of a Saan. Contemporary photograph. Whalebone or walrus tusk tyres are generally preferred because of their lower friction. Preparing the runners for a long journey is as important as waxing skis for racing or Langlauf. So-called ice tyring systems are known everywhere in the north. Before departure the underside of the runners are wiped several times with warm water to form a surface of minimal friction. During long journeys the drivers take along powdered peat. From this a paste is prepared and applied at least once a day. *42*

A team of three are harnessed to the Saan—not traditionally Lapp and almost certain to be of North Siberian influence, 1934. (Plate III). *43*

In April the move from the winter village begins. They travel with several sledges linked together forming a caravan called a Raide. Reindeer cows as well as bulls have antlers, the only deer species with this characteristic. The bulls shed these in the winter to grow more decorative ones as they mature, while the cows retain theirs until they have calved in May. *44, 45 and 46*

The human and animal families are now moving off, all tucked in warmly in the pulkha. Wherever possible frozen rivers and trails are used. By June the route has become impassable; the snow has changed to bog. Contemporary photograph. *47 and 48*

Pulkha construction: the number of ribs varies according to size and these are fastened to the keel with nails in square holes in the fashion of Swedish boat making. *49*

Making a Komi type sledge: this is the most crude type of the built-up sledge and its construction by morticed posts strengthened by lashing goes back to antiquity. (Plate III). *50*

Reindeer mail service makes sure that even the most lonely settlement is kept in touch. The Rislareki is ideal for driver and parcels. *51*

Helyn Malm, district nurse, leaves for a remote settlement. She also carries a good supply of lichen—her reindeer's food for the journey. *52*

# Dog

Zoologists and others writing on dogs often introduce their theme with the categoric statement that the dog was man's first domestic animal. I am not quite so certain in the field of snowmobility. Circumstantial evidence such as prehistoric remains of sledges is inconclusive: their basic construction is identical for use with dog or reindeer. Design differences came much later.

The North Siberian tribes were one of the first people known to have domesticated reindeer and they also trained dogs for herding. As one of the four husky breeds, the Samoyed originates from their land and is still used for both purposes today: I think that dogs first pulled sledges at the same time as reindeer—5000 BC I am strengthened in this belief because domestic and transport management progressed on similar technical lines and to identical time scales throughout the Arctic and sub-Arctic terrain.

The Ostiacks' method of travelling in winter, seventeenth century. This is one of the forty North Siberian tribes. The Samoyed husky is the smallest of the breed and more akin to the primitive dog than any other. It is not related to the wolf, and is gentle, friendly and companionable; a strong and intelligent worker in herding and sledging. The Siberian husky was brought to Alaska from the Kolimar river region of Siberia in 1909. They are fairly small and very fast. In former days they were used extensively in the famous US mail teams in Alaska. The Malamute (or Malemute) named after the Alaskan Eskimo tribe are big, powerful and rather shaggy dogs. While the fast Siberians raced through the north with the mail, the Malamute pulled huge loads of freight. In 1954 one of these huskies set a world record by moving a sledge with a load of nearly 1 ton. The Eskimo dog or husky is akin to the Malamute but lighter and smaller. There has been much interbreeding and also mixing with other breeds such as Alsatians and St Bernards, and they come in all colours. *53*

Mandan Indians with skin sledge. Dogs are harnessed in tandem, a method common in the forest and on the trail, late nineteenth century. There are only two conventional harnessing methods originated by the Eskimo and used throughout the north:

*The fan hitch:* (Plate IV). The true fan hitch is used in open country. Each dog is harnessed to the sledge by individual traces of equal length. According to the terrain, length varies between 4 m–6 m. Usually at least one bitch is included to ensure a high spirit among the dogs. Speedy harnessing is the great point of this method, the disadvantage is that the long ropes get hooked on ice blocks and knot up during the journey. There is no leader dog and the driver (musher) addresses his commands to the team. In practice the most intelligent and co-operative dogs are harnessed at either side.

*The double tandem hitch:* (Plate IV). The dogs are harnessed in pairs to a centre trace with the lead dog at the head. The main disadvantage is the more complex and, therefore, slower harnessing, but once the team is on the way there is less chance for knotting and entanglement. The key to a good team is the lead dog. 'In dogs as in men, the true leader is born, not made; training may increase his gifts, it cannot produce them.' (Diamond Jenness). The leader is not necessarily the strongest but always the most intelligent. The lead dog must instantly understand and obey the musher's orders; many Eskimo drivers rely solely on verbal directions and use no whip. *54*

Eskimos on a fast run. The sledge is a primitive Komatik (Plate II) and the husky team is harnessed in a fan hitch. Two dogs are fighting, as is their custom, and one seems to have broken loose, 1884. *55*

The kayak is about to be launched and the advantage of the fan hitch—free movement for the dogs—shows up clearly, Greenland, 1933. *56*

This very large Komatik is 10 m long but only 50 cm in width. The heaviest load is placed on the foremost cross-slat so that the rear can be swung round easily. The photo was taken in Greenland in 1933. *57*

When the normal raw materials for sledge building—wood, whalebone or ivory for the runners—were not obtainable the ingenious Eskimo could still make a sledge. They shaped runners from soaked seal or muskox hides. Frozen solid they kept their shape until the first thaw. Frozen fish was used as crossbars. They made serviceable transport which had a unique advantage: in times of need the sledge could be eaten.

This husky team in Labrador is harnessed in double tandem with the leader at its head. A team of five will haul a heavy sledge with a load of 200 kg for 50–75 km per day on reasonably good ice. But if they are pushed and carry a somewhat lighter load they can cover, with little rest, 170 km in 24 hours. Up to 50 kg per dog is a permissible load with a reduction for the smaller dogs. *58*

A team of eight with one of the most advanced types of built-up sledge on the hills near the Alaskan Highway. (Plate III). Fred Bruemmer states that their daily ration of food is $\frac{1}{2}$ kg of meat and 250 g of fat (blubber or tallow) per day. US army manuals recommend 1 kg a day but do not refer to fats. Given the chance a husky, like a wolf, can gulp down as much as 7 kg of meat in a minute but can also go without food for days and carry on work. *59*

This trapper is on his way to the trading post at Broadpass near Healy, Alaska. The single tandem harness is peculiar to trapping with difficult and narrow access and soft deep snow, *ca* 1900. *60*

Local job on the Alaskan Highway. *61*

Plane and dog and, during the last few years, the snowmobile share the transport needs of Alaska. For short distances and in isolation the husky is indispensable. *62*

Resting. *63*

Status transport for the young: the harness of the impressive Newfoundland dog is clearly modified from a Shetland pony outfit. *64*

# Horse

Millions of words have been printed about the horse and authors add more every day. Therefore, I decided not to join the word-race and try only to show our noble friends' role in snow travel and transport.

The earliest pictorial evidence of a horse-sledge I could find is this detail of a painting by Anton Sisky at the State Historical Museum, Moscow. 'A scene by the Gates' is the title and the date is 1648. The ancient boat sledge has been fitted to a two-runner chassis, equipped with shafts. Although the harness is stylized, the Douga is clearly shown, a characteristic of Russia and Eastern Europe. *65*

The Siberians and the Bavarian peasant couple travel on sledges which are identical in construction to the very early sledges of the Lapps and Eskimos. The only difference is the length and angle of the shafts to suit the larger animal—the horse. Not unexpectedly the Bavarian load includes a beer barrel (1880 and 1845). *66 and 67*

A St Petersburg omnibus on its route at full speed. The team of three is a Troika, a term which refers to the method of harnessing and the number of horses and not to the vehicle itself. The word 'Troika' means three and is also used in card games to indicate the three of spades or to describe a man's three-piece suit. The coachman is seated in front high up—a fashion common to public transport through the coaching days to modern motor buses. *68*

Passing in front of the fortress and Cathedral of St Peter and Paul at St Petersburg (Leningrad today), this Troika taxi provides no seat for the driver: he stands up and this is common practice. The lines of the sledge body show clearly the influence of the bronze age skin sledge which is emphasized by the leather apron. The passenger seats are kept low for good roadholding. The campers on the left are probably nomads from North Siberia on a visit to St Petersburg for trading. Their transport—a reindeer sledge in which they had covered some 2 500 km on the way to town.

*The Troika harness:* (Plate V). This is unique to Russia and the Douga is a development from the yoke. The centre horse works between two shafts and the two outside horses are harnessed with leather traces. The Douga carries the weight of the shafts and being attached to the collar with flexible links, acts as a shock-absorber. The centre horse trots, the outsiders canter. The driver controls the Troika with four reins; in the centre of each hand he holds the reins of the centre horse and the outside reins of the two side horses lie in the outside of his hands; their inside reins are fixed. The heads of the outside horses are turned slightly outwards, the left horse canters with the right and the right horse with the left fore leading, a pace called counter-canter. *69*

On a long journey the coachman often fixed the reins of the centre and one outside horse and drove the most trusted horse only. The wooden Douga of the outfit is decorated with inlaid or embossed silver in intricate designs. For safety and to prevent overturning, two outriggers protrude from either side of the sledge to just above the ground. As we have seen so often, sledge builders have taken their lead from the shipyard. Also, for the first time in the history of the sledge, we begin to feel the influence of the coachbuilder. Long distance sledges made by Romanov—the most celebrated of Russian coachbuilders—were light and strong, open in front and fitted with a tarred canvas hood that could be totally shut at night for protection against the wind and snow. The passengers travelled and rested on mattresses laid over the trunks. The jolting on a cross country journey cannot be described; it must be experienced. To keep the mattresses reasonably flat and comfortable, the driver stuffed hay underneath at

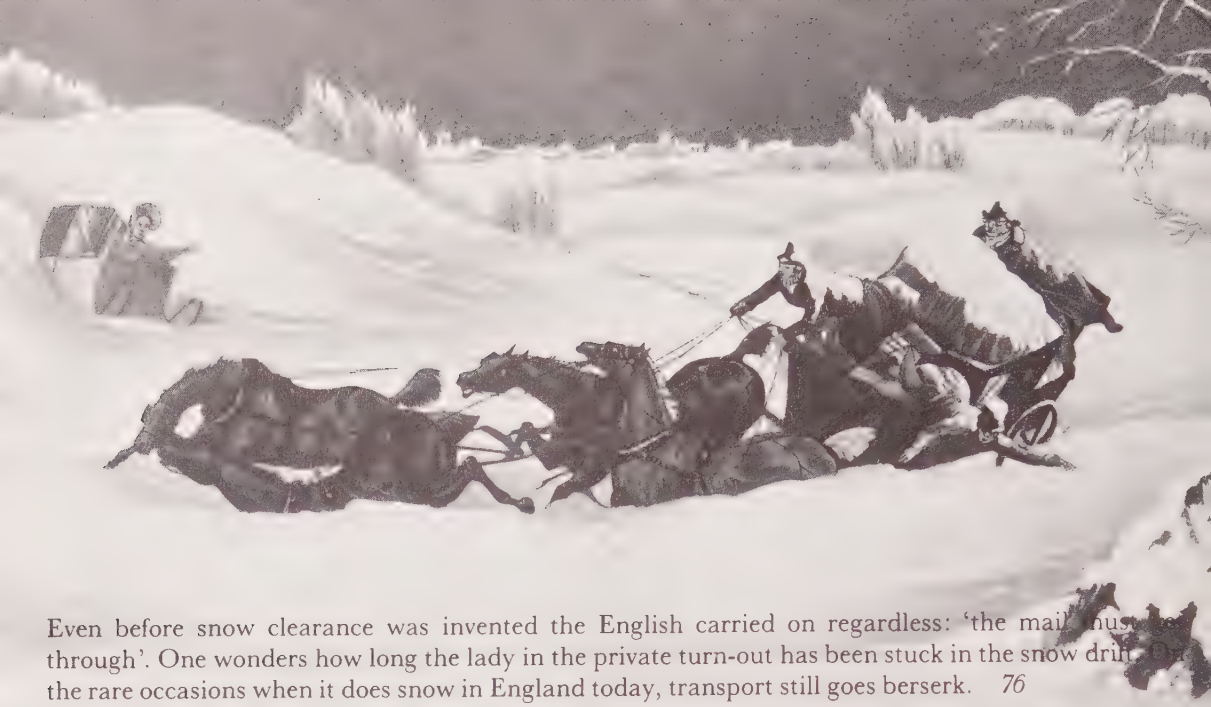
regular intervals. Siberians were not dismayed to undertake journeys of 3 000–5 000 km in these sledges, even with breast-fed babies. Where possible frozen rivers served as highways. For speed the heavily-laden freight sledges followed one another as the regular trade routes were well compacted. As everyone tried to stick to these lanes, this inevitably led to many crashes. *70*

A drive through a snow storm in the famine-stricken districts of Russia 1892. 'We were nearly at the end of this ordeal of ice when the near-side horse fell and in a second there was nothing to be seen but legs and tails and bits of harness flying about; while the driver and I who, thanks to our felt boots, were able to stand on the ice, had hurriedly jumped out and had got hold of the sledge to prevent its disappearance into the river below.' *71*

A Canadian mail sledge near Montreal. The team of three are harnessed as a pair and leader, known as pickaxe or unicorn. The coachman drives three horses which work in unison, contrary to the Troika, where the centre horse drives and the two outsiders canter. (Plate V). *72*

Swiss mail sledges on the Albula Pass going through snowdrift tunnels. The four-in-hand are harnessed to a single long bar behind the leaders. English and German practice prefers a set of bars seen on the mail coach and King Ludwig's Bavarian turn-out. (Plate V). *73 and 74*

Goods trailers are favourites with the Swiss postal authorities. To this day their buses pull luggage trailers. The passenger compartment would look happier on its original wheeled chassis. But the Swiss are economical people. *75*



Even before snow clearance was invented the English carried on regardless: 'the mail must go through'. One wonders how long the lady in the private turn-out has been stuck in the snow drift. On the rare occasions when it does snow in England today, transport still goes berserk. *76*

Goods and passenger transport in New York in the second half of the nineteenth century. Both sledges show originality in their construction. The truck sledge has a high curved dash front and the runners and shafts are steam-shaped from a single piece of ash. The omnibus, seating twelve in comfort, has a tubular steel chassis. The six-in-hand are driven from the box with obvious skill and pride. Their unified action and rhythm is perfect. Typical for passenger transport, the coachman's position is high up in front. He controls his team by reins and voice, using cautionary words of command. (Plate V). Note the bells on the three pairs—a law requirement in most countries. *77 and 78*

Breaking young horses to sledge harness in British Columbia. There is no doubt in my mind that these skin-type training sledges are designed and built for the job. But where are the reins? How do they stop? The long shafts are typical for practice and training vehicles. They prevent the horse from damaging the sledge. The flat platform, dispensing with runners, offers the trainer close to ground balance. Could it be that the underside of the platform embodies friction ribs offering resistance to speed intended to tire the learner before the instructor? *79*

Sledging in the Isle of Bute, 1886. 'We try the grey colt in our sledge and he proves frisky. The sledge breaks down and he stampedes with the old black horse—they take the driver with them. Coming home he earns his corn.' *80*

Status transport arrived with the horse. Contrary to the Northern cultures where reindeer and husky dogs formed part of a classless society, the number of horses and carriages owned became synonymous with owners' status and wealth. Ludwig II, King of Bavaria, (1845–86) was a romantic on the throne. The tales and folklore of his fabulous rides through the mountains and by torch-light at night, are still alive today. There is no coachman, the left horse of each pair is ridden by the postilion. In East Prussia the heavy wagons and sledges were always hauled by a team of four Trakehners. Traditionally the lead horse is ridden. The figurehead carrying the crown is another example of shipbuilding tradition. *81*

THE ROYAL SLEIGH.

Queen Victoria with two of her daughters on a drive through Windsor Park in a town sleigh. The Royal Mews Harness, seen here, is still used today. Tolstoy's description of a sledge for a princess suits this English Victorian outfit. 'It was a wicker sleigh lined with velvet, the harness had little silver buckles on it and the reins were of silk, as was the netting. The harness was such that when all the belts and straps were in place and fastened you could not tell where the harness stopped and the horse began.' England 1850. *82*

Prince Albert, Queen Victoria's husband, on an informal drive, passing the Obelisk on the Thames Embankment, London, England. *83*

An artist's impression of Haarlem, New York, in the winter. In common with many other artists this one pays no attention to detail. There are no shafts and, and on slowing down, the carriage would run into the horse. *84*

Sledging in Stockholm, 1850. A typical winter traffic scene with a very smart turnout and a farmer's box sledge pulled by Iceland ponies. *85*

SLEDGING IN STOCKHOLM.—FROM AN ORIGINAL DRAWING.

Caribou hunting in New Brunswick, Canada 1863. The tandem suggests narrow forest tracks. In common with most Western harness, blinkers are worn and the bit is a curb. Russians use snaffles and no blinkers. *87*

Going to a Christmas party in a four-in-hand, Citadel Hill, Quebec, Canada 1880. *86*

This is not a caravan. The fisherman takes the small hut on to the ice for ice-fishing. When he has chosen the right place, he cuts a hole in the ice directly under the hut and fishes through the ice with the comfort of a heated mini-house. A report in the Russian horse journal *Konyvodstva I Konysport,* highlights the dangers of ice-fishing. Two fishermen were about to return home with their catch when a large section of the ice detached itself and drifted out to sea. After a while they heard some neighing and a horse-drawn sledge came toward them at speed: there was nobody in the sledge, the driver had been separated when the ice broke loose. The fishermen boarded the sledge and kept themselves warm while the ice continued to drift. After two days they came to rest near human habitation, revived the frozen horse with massage, spirit and food and were none the worse for their adventure. *88*

This donkey on his milk round was in evidence daily in the sixties. Mürren, Switzerland. *89*

# Rails on ice and snow

In my search for material I visited the Swiss Museum of Transport and Communications at Lucerne and told the librarian, Herr Wismann, the subject of my writing. I asked, in particular, for illustrations of railways in the winter. 'But trains don't go on snow, they travel on rails, laid on solid ground. All you want to show your readers is how they keep the tracks free from snow and the points unfrozen.'

At first his negative response disappointed me but slowly the simple logic of his utterance sank in and made sense. Good sense indeed, for four-fifths of the world's land area. The surface of the remaining one fifth, which includes almost half the Soviet Union, much of Alaska and one third of Canada, is permafrost.

This is how the permafrost stratum appears. Normally the zone is hidden in the depth of the earth but here the river has washed away the shores and exposed the ice of the time of the mammoths: permafrost. This phenomenon involves two layers of the earth's outer crust and for eight to nine months of the year they are frozen solid. When the thaw comes in the spring the active layers melt to a depth of some 90 cm–150 cm while the lower mass remains frozen. In the regions of permafrost which include some of the immense complex of the Trans-Siberian Railway, trains travel literally on snow and ice in the true sense of the book. So I decided to accept Herr Wismann's wisdom and confine myself to snow-management where the tracks run on solid ground and relate only the cruel tales of the true snow and ice line: the Trans-Siberian Railway. *90*

A planning committee, chaired by the Czar, was formed in 1887 and work on the eastbound tracks began five years later in 1892. Heavy frost limited the all-out working period to a maximum of four months and in many sectors to three. The eight or nine winter months were utilized to bring forward supplies of building materials and tracks. Horse-sledges could carry over double the load on snowed-up roads and frozen rivers, compared with dirt tracks. Bridge building and station construction too, progressed throughout the winter. *91 and 92*

Long before bridges were ready, completed sections of the railway were opened for 'provisional' traffic. Passengers travelled in fourth-class carriages attached to supply trains and got across the frozen rivers best as they could. They walked over the narrow streams and for traversing wide rivers such as the Ob, local sledge drivers stood by to take the passengers over the ice. The train itself preceded the passengers across the river on tracks. These were ice-welded to the frozen surface by continuous douches of water carried in buckets from holes in the ice. Every civilized person carried a revolver or two if he was of a cautious temperament. Nobody thought of going out after dark and every week somebody was raped or killed. The whole population was ex-convict or worse. Not until five years later—April 1897—was the seven-span, million dollar bridge over the Ob completed. Man power presented no problem: criminal and political prisoners numbered thousands. A contemporary report by Henry Norman states: 'a short time before my visit another murderer employed on the ship tried to repeat his crime and had been confined to chains again, the very day I was there the police were looking for a man who was supposed to obtain work in the

yard who was wanted for killing eight people. There are a few Cossacks there but they are wholly incapable of coping with the turbulent place. A few months before my visit they held up the mail cart from Lake Baikal to Irkutsk, shot four of its five guards and stole the gold—some day they will hold up the train and rob the passengers.'

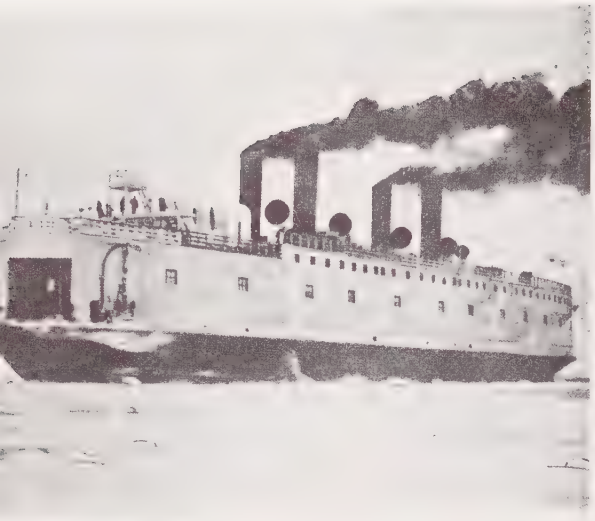
*Permafrost:* in the mid-Siberian sector working conditions were even worse at –60° and barely three months good weather. The problems facing civil engineers would be formidable even with 1977 technology. But without mechanical power or transport and only more and more expendable men and horses, logs for heat and dynamite for holes, only superhuman determination could succeed.

The combination of temperature differences and hydrodynamic forces literally melted away embankments and walls of cuttings after the thaw. In winter, expansion of the ground moisture on freezing, created hummocks that heaved high the tracks, only to subside in the warmer months. Sleepers and rail either sank in waterlogged holes or arched up in the air. The pilings of timber bridges were thrust upward to unequal levels where some remained and others slid back distorted.

Permafrost building techniques were established the hard way by trial and costly error. They learnt to dig away the unstable and active surface layers and dynamited holes deep into the permanent ice. When supplies ran short they lit innumerable wood fires and patiently thawed out the permafrost. Then they dropped down piles, held vertical by temporary wedges, poured in water and allowed the frost to make an everlasting concrete bond. Fifteen million sleepers were used to complete the line.

*Lake Baikal:* their Excellencies planned to skirt the eastern rim of Lake Baikal to connect Irkutsk with Mysovsk. However, surveys carried out in 1890 revealed a terrain hopelessly obstructed by mountain ridges and river gorges. The number of viaducts and embankments, bridges and cuttings, and a tunnel more than two miles long, not only put out the project financially, but proved beyond the technical resources of the time. In 1893 the 'Circumbaikal Loop' was postponed *sine die*. Instead their Excellencies decided to transport the train complete with passengers and freight on steam ferries to be built for the purpose. They instructed an engineer to study the icebreakers of the go-ahead Americans on the Great Lakes. The engineer's recommendation was a wooden train-ferry similar to the Saint Marie on the Straits of Mackinac. The chief engineer disagreed and convinced the committee that a steel hull would be essential; he was granted $1 500 000 for vessel, landing slips and repair shop. Sir W H Armstrong & Company Limited submitted the lowest tender and contracts were signed on 30 December 1895. Within six months Armstrong's shipyard at Newcastle upon Tyne built the icebreaker ferry from the keel up, painted and stamped every part with an identifying number, then dismantled the whole and shipped it in sections to Listvyanka for reassembly. Machinery, boilers and ancillaries followed in December 1896—one year after the date of the order.

Today the Institute of Permafrost Studies collates, evaluates and classifies seventy-five years of practical work in permafrost areas and has evolved scientifically based permafrost building techniques. *93*



The *Baikal* icebreaker and train-ferry. She combined the physical features of a tubby polar icebreaker with those of a top heavy excursion boat. She carried the passenger coaches or twenty-eight freight wagons on three pairs of rails laid parallel with the keel. There was room for 800 passengers. In the summer of 1897 the chief of Armstrong's shipbuilding staff went to Siberia to supervise the *Baikal*'s reassembly and she commenced regular service from the new port of Baikal in April 1900. *94*

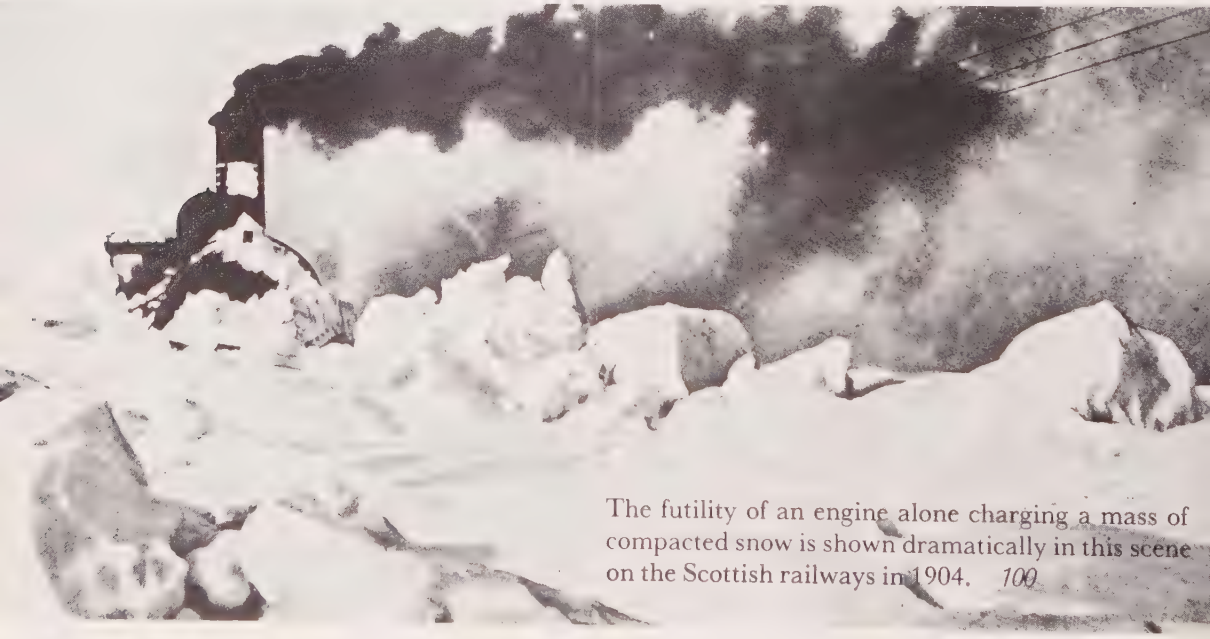
A much smaller and lighter icebreaker ferry was put in action only a little later. The *Angara,* also built by Armstrong's, carried passengers and freight only and assured service should her big sister break down. The *Angara*—60 m long and 10 m in the beam—seemed a greyhound beside a St Bernard when compared with the *Baikal.* Her top speed was $12\frac{1}{2}$ knots and she carried 150 passengers and 400 tons of cargo.

Both ferries were doomed to fail. Hydrographers had underestimated the depth of midwinter ice cover on the lake and the *Angara* could not get through unless the *Baikal* broke a path for her. An American traveller, Michael Shoemaker, reports on board the *Angara* in 1902: 'the *Baikal* has cleared the passage for more than halfway—some 35 km—and we find her hard at work. She has backed off about 200 m and rushes at the ice before her with full steam. There is a crack and a roar as the ice gives way and great blocks turn their glistening edges upwards and, piling for a moment at either side, close again behind the ship. . . .' Where the ice was really thick these repeated onslaughts took so long that it became routine for the *Angara* to disembark the passengers on the frozen surface, where a hundred or more sledges waited to take them to the waiting trains on the opposite shore. *95*

Trans-Siberian Railway passengers crossing Lake Baikal in sledges from terminus to terminus. The horses' shoes are fitted with sharp spikes for grip. The trees inserted into the ice serve as route-markers. In February 1904, the Japanese launched a surprise attack against the Russian fleet in the Far East which started the Russo–Japanese war. The Japanese had timed the attack well. They realized that the entire war machine which St Petersburg was rushing east through the Urals would come to a halt at Lake Baikal. The two steamers were frozen in and there were only sufficient sledges at Baikal for ordinary passenger transport. Their Excellencies devised a brilliant emergency programme for movement of troops and supplies across the lake. Locomotives and rail-wagons arrived at Port Baikal and an army of workers toiled at temperatures of 40° below zero to lay rails on the ice to the village of Tankhoy. Since test borings had indicated that the ice was 1·70 m deep, locomotives could safely cross the lake under their own steam. But Old Man Baikal decided otherwise: the first test engine plunged through in a disastrous demonstration of the lake's treachery. At intervals, warm springs had thinned the ice. But the Trans-Siberian committee remained determined to link their land with the Pacific and a few years later they commenced to circumvent the untameable Baikal through the once impregnable country that surrounds it. Rail travel over the frozen lake was no longer the programme. *96*

New cities and settlements in Siberia call for continuous extensions of tracks. Today a caterpillar track layer and three men have replaced the convicts of 1899 and eight thousand horsepower locomotives haul trains weighing ten thousand tons. For the climatic conditions where 50° below zero is no exception, gas turbines are considered most suitable. Their cruising speed is over 100 km/h. *97 and 98*

Success of line clearance depends largely on the traffic frequency. Even very early locomotives operating in cold countries were fitted with pointed ploughs, some 7 cm above the track. When pulling a train, they could shift only minimal snow but on their own when the engine power served only one purpose, fresh snow up to 2 m high could be dispersed. Locomotives cannot, however, cope with heavy snow falls, particularly after standing overnight. The thick snow cover compacts between axles and body or the snow between the rails reduces adhesion and annuls traction. This is the time to employ an independent snowplough. Two locomotives push one of these rammers on the Grand Trunk line in Canada 1884. *99*



The futility of an engine alone charging a mass of compacted snow is shown dramatically in this scene on the Scottish railways in 1904. *100*

With hindsight it is difficult to understand what made the engineers of 1900 so blind to the obvious. After pushing more and more snow from the track, there comes a point when the snow walls at either side are too high and too hard to yield. Obsessed with this task the driver rams on. This photograph was taken in Sweden showing the extensive damage to the engines and danger to personnel. *101 and 102*

SNOW PLOUGH FOR RAILWAYS -
Two wheels with curved blades are mounted in front of a locomotive and are driven in opposite directions by belts and pulleys from a motor.

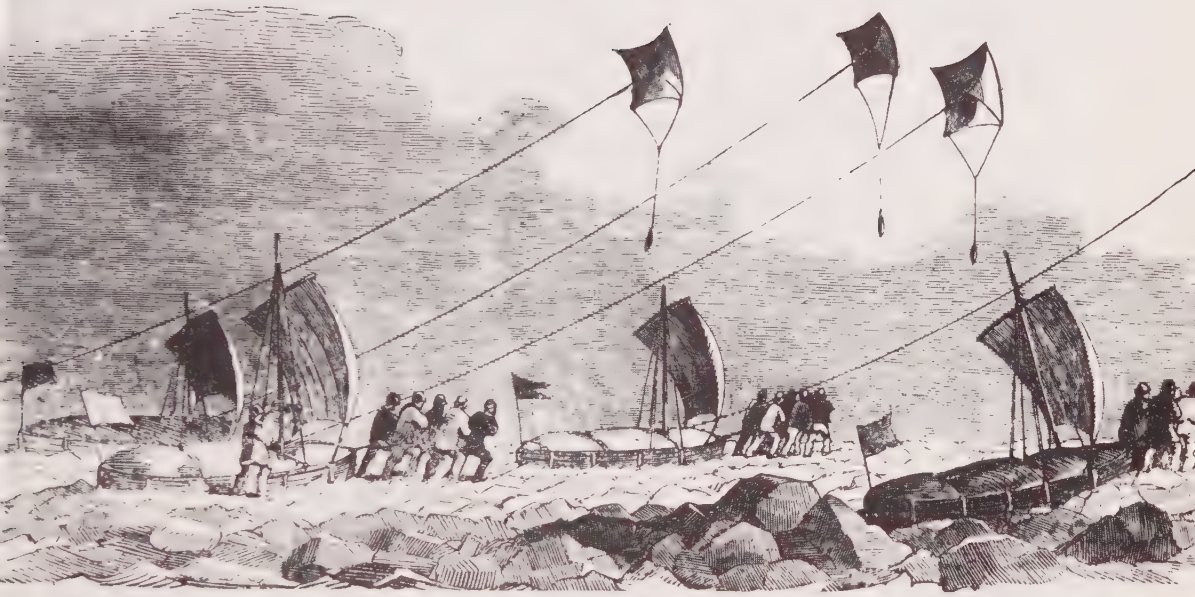
On 29 January 1921 the *Illustrated London News* published some 'Curiosities and Ingenuities of the Patent Office'. The snowplough for railways was one of them. Neither publisher nor inventor could have known that today's line clearance is based on the designer's principle of throwing the snow high and far away from the track. *103*

Snow-thrower pushed by diesel engine clearing

This contemporary steam powered snow-thrower works on the famous Gotthardbahn in Switzerland. The latest machines are diesel powered and combine a plough with two throwers, dispersing the snow in a fine jet of powder over a wide area. *105*

Bernina Line, Switzerland—line clear. *106*

# Extreme north and south



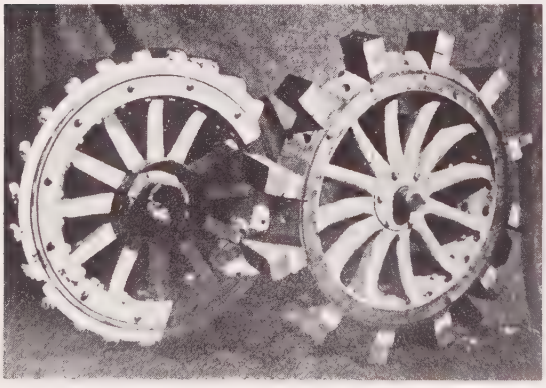
Expeditions and wars have certain common factors: both spur progress. Both give the inventor a chance and need genius for their successful conclusion. Only genuine leadership, common sense, tenacity and adaptability count; everything else is taboo. How many sessions and how many hours of deliberation would Captain H T Austin's planning committee (*ad hoc* section snow vehicles, sub-committee on power assistance) have taken to tear to shreds the sail and kite sledges which helped his team to traverse Melville Island in 1851. His western division of sledges used the Lapp's boat design—probably with a single runner. I guess that the sails and kites were an afterthought as friction proved too much for man hauling. At extreme temperatures in the far north, snow does not fall in flakes. It settles in granules, reducing the gliding action of these heavy sledges with their large sole-to-snow contact and makes movement a misery. *107*

During a period of thirty years between 1848–79 more than forty search expeditions tried to solve the mystery surrounding the death of Captain John Franklin. He died in June 1847, in the icefields north of King William Island and the Admiralty offered £10 000 and Lady Franklin added £3 000 for precise information about his death. These searches have done much for the charting of the Canadian archipelago and the establishment of the North West Passage. Lieutenant G Schwatka, USA, used dog teams and simple two-runner sledges in his 1879 search expedition. Downhill the huskies are unharnessed so that the sledges do not overrun. These handling tactics are still used in Bavaria today. However, the Bavarian Bauernschlitten has two horns at the front and one man can bring it safely downhill; trees and hay are transported in this manner.

Most expeditions used the traditional Eskimo sledge, rather heavy and wide with narrow runners. Later Nansen designed his own sledge, far lighter and equipped with wide ski runners to decrease friction on soft snow. Otherwise construction remained traditionally Eskimo: no nails or pegs were used and joints were lashed. Until high density polythene became available in 1950, sledge runner design had remained essentially static for a century. Ski manufacturers such as Head and Rossignol have done much research on this subject for downhill racing and the results were applied to sledge tyring by Hugh and Myrtle Simpson in The Far North and Fuchs in the Antarctic. *108*

Tremendous interest surrounds this picture. When Lieutenant Shackleton announced his South Pole expedition in 1907, this black and white drawing hung in the *Nimrod* during King Edward VII and the Queen's visit to the ship. Shackleton's perception and understanding of snow transport of the future was uncanny. The artist's impressions, a mirror of Shackleton's hopes, later became reality. *109*

By car to the South Pole is the title of an article in the October 1907 issue of *The Car* and shows a photo of Shackleton's Arrol-Johnston made in Paisley, Scotland. It has a 4-cylinder 12–15 hp motor with Bosch magneto ignition, is air cooled and has a 4-speed gearbox. A pipe from the exhaust goes to the carburettor and passes under the floor to act as a foot warmer; finally it leads through a small tank for melting snow for cooking. Go-ahead thinking indeed for 1907. The front wheels had solid rubber tyres and detachable runners are slipped under them. Lieutenant Shackleton explained to a press conference that he would not venture to the North Pole in a car because of the rough surface and the hills, whereas remarkable smoothness is the pattern in the Antarctic, quite feasible for a wheeled vehicle suitably modified. *110*

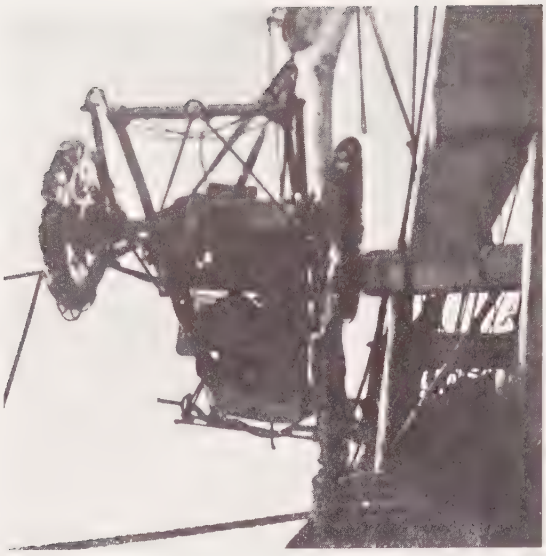


These are the modifications Shackleton spoke of. On the left is the first prototype. The second model has much enlarged traction sections on the rear wheels. *111*

In action neither of the special traction wheels were needed. This photo was taken in the Antarctic and at time of compacted snow, even the front runners were detached. *112*

Shackleton distrusted dog teams and pinned his hopes on fifteen ponies which he imported from Manchuria. The maize crusher is outside the Arrol-Johnston's garage. The ponies were a mistake; they could not acclimatize and moved only with difficulty when pulling the sledges. *113*

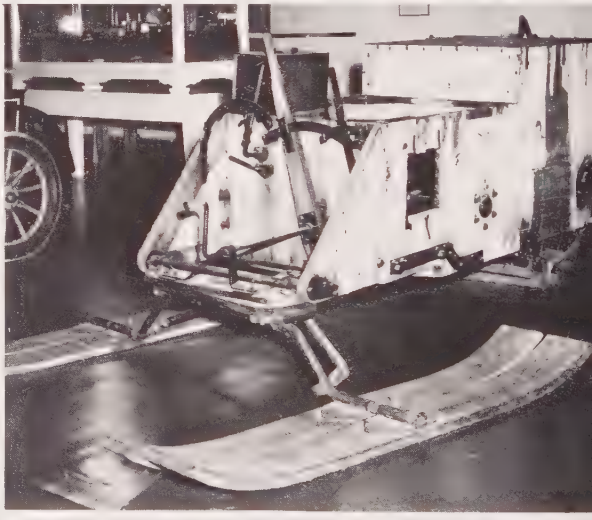
In addition to carrying iron rations and three to four passengers, the car was able to pull sledges and averaged 45 km per day. *114*



Shackleton wintered on Ross Island and his Arrol-Johnston took him within 150 km of the South Pole. Here the car is hoisted on board the *Nimrod* for the return journey in 1909. *115*

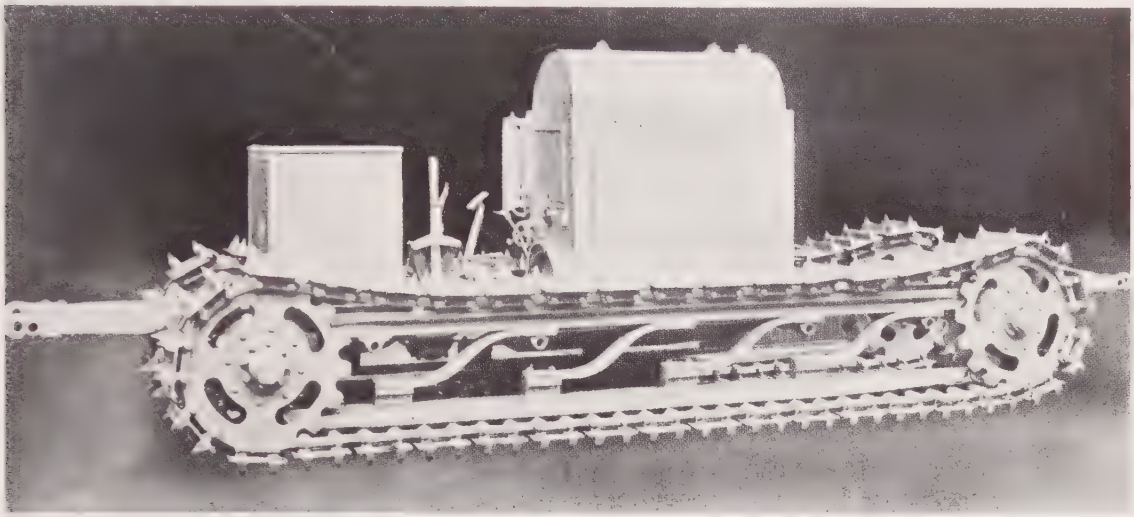
Shortly after his return, Shackleton prepared for the Trans-Antarctic Expedition which eventually set forth in 1914. This time he took dog teams and propeller sledges designed by René Legrain. This is the prototype. *116*

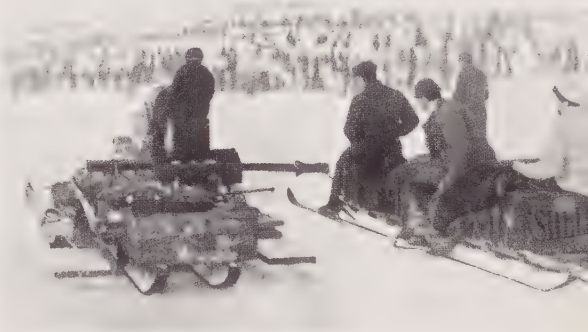
The propeller sledge is well suited to open country where it can travel at speed. For the Antarctic it seemed a good choice, as the poor manoeuvrability of the design was not important. Air sledges are still used in Siberia today for fast passenger transport. *117*



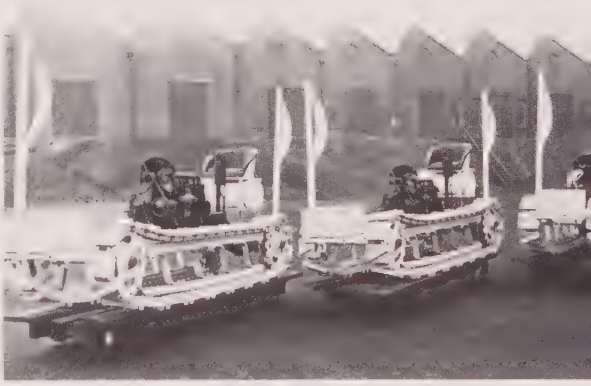
The most remarkable member of Shackleton's fleet was a motor tractor of extraordinary design, with tiller steering at the front operating two ski runners. It was propelled by a rotary shovel or paddle in the manner of a Mississippi mailboat. It was brought back from the Antarctic to the Dominion Museum, Wellington, New Zealand in the fifties and lacks the engine. Another example of Sir Ernest Henry Shackleton's flair for snowmobility. *118*

In 1907 snow transport technology leapt half a century ahead with Belton B Hamilton's design for Captain Scott's snow-tractors. They were made by the Wolseley Tool & Motor Car Company of Birmingham, England, and powered by their 12 hp 4-cylinder engine. Transmission consisted of a 4-speed gearbox, connected through cardan shaft and worm gear to the rear axle. Both axles have sprocket wheels for the steel tracks which are sprung by 'S' shaped spring steel shock absorbers. Revolutionary for the time was the approach to steering: this was achieved by braking one of the tracks, with the result that the vehicle would turn in that direction. *119*





Thorough field trials were conducted in Norway. As a result numerous changes, mostly connected with low temperature environment, had to be carried out. In the photo Captain and Mrs Scott are riding on one of the trailer sledges. *120*



Scott's tractors are leaving the factory in 1910 for shipment to the *Terra Nova,* the British Antarctic Expedition's ship at Port Lyttleton, New Zealand. In the final version the petrol tank was moved under the driver's seat and a water tank, behind the engine, was heated by the exhaust gases for domestic supplies. Front and rear were lengthened by removable stretcher poles to minimize the danger of dropping in crevasses. These pieces had a secondary use as tent poles. *121*

Not since 1914 had anyone attempted this immense trek, until Sir Vivian Fuchs' crossing of Antarctica in 1957. Though half a century had passed since Shackleton exhibited his Arrol-Johnston ice car, the problems of raising public interest and money remained the same for Fuchs. The mural painted by Victor Hasslauer, to provide a vivid and realistic background to the Snocat display in London in 1955, is very similar to Arthur Garratt's drawing in the *Nimrod* of 1907. The simile does not end there: Sir Vivian Fuchs also turned his dream into reality. *122*

The transpolar party had at their disposal eleven vehicles of which the four Snocats were the most photogenic. All had petrol engines because of their easier starting at –45°C. The Snocat is made in the USA by the Trucker Corporation and has a 200 hp Chrysler V-8 engine. The two tracks are driven by propeller shafts and each pontoon is free to turn about its axle and is sprung with leaf springs connected to the steering platform. A conventional steering wheel in the cab actuates the hydraulic system which turns the pontoon tracks. A special point is that the front pontoons point to the right when turning right but the pair at the rear turn to the left. This proved to give far better traction than any of the two-tracked machines, especially on soft snow. *123*

Performance: up to one ton could be carried inside the body of the Snocat and two sledges loaded with a total of five tons were hauled. The sledge runners were shod with low friction plastic similar to skis. A good cruising speed was 10–15 kph but on hard, iced-up snow great care had to be taken by the drivers and speed was reduced to 3–4 kph. The wheel at the rear is a tachometer also used on the dog sledges. *124*

Despite the impressive mechanized fleet, husky sledge teams and scouts on skis were still vital for reconnaissance and route finding. Dog sledges also remained the only possible transport in mountainous terrain. Crevasses of up to 1·50 m presented no difficulties for the Snocats and other track-sledges. But as ski mountaineers know only too well, even 'solid' snow bridges collapse without warning and a small crack in the snow may turn into a crater. This is what happened here. Recovery was made with the aid of alloy bridging sections. *125*

A much-modified Ferguson tractor with radio caboose, makes its way to the South Pole. Originally a standard 28 hp farm tractor made in Coventry, England, Fuchs connected front to rear wheels with an endless belt consisting of two canvas covered rubber belts with steel cross-links. The normal steering was locked. Change of direction took place by using the standard independent brakes on the left or right drum to make a turn. Depending on load and snow, speed was up to 18 kph. *126*

The Muskeg is a fast mover with excellent traction on hard surfaces but poor on soft snow. Tracks and steering are conventional, maximum speed is over 40 kph with a cruising average of 18 kph under load. Its 6-cylinder Chrysler motor develops 115 hp. They are in regular use by the British Antarctic Survey for charting. *127 and 128*

The best description of this 'International Harvester' tractor is a polar builder's shovel. It clears snowdrifts, helps to build snow houses and dog shelters, moves supplies, frees sunken sledges and makes under-snow stores. The single full width track gives it formidable traction with minimal ground pressure. *129*

The Gnat is a land tractor developed for snow and ice by the Australian John Darby of Canterbury University. Its design stems from the approach to traction problems in motor racing, where large square section tyres of low pressure ensure a very large wheel-to-snow contact. Two independent swing axles at the rear suggest high ground adhesion. *130*

Supplies arrive and the Emperor Penguins direct operations. In case you are without compass, penguins are a sure sign of Antarctica—they do not live in the North Polar regions. *131*

Royal research ship *John Biscoe* frozen-in at Darbel Bay on the West coast of the Antarctic peninsula. *132*

*The Lenin* atom-powered icebreaker, flagship of the Soviet icebreaker fleet, leads cargo ships through the seas of the Arctic Ocean 1972. *133*

Horse, dog or motor—when all else fails willpower and manpower take over. *134*

# Motor power

Right from the start trains were expected to run summer and winter. The early cars were not and Henry Ford's ambition was to provide reliable transport 'that wouldn't get stuck in the mud'. At the time of the birth of Henry's Model 'T' in 1908, most car owners used their automobiles in good weather only. A few doctors and farmers ventured out in the rain and braved the slush on the unsurfaced roads. Snow clearance did not exist and even the most progressive car maker did not visualize his automobile driven over snow. Trams gave up during heavy snowfalls with the exception of the enterprizing management of the Dresden Heidebahn in Germany. In the cold winter of 1903 they kept their trams on the snow by fitting traction wheels with a tooth profile and sledge runners on the rear.

Tramway sledge, Dresden, Germany 1903. *135*

By 1907 inventors were inspired by Arctic explorers who began to favour motor sledges as polar transport. Two schools of thought became apparent, both aiming at the same objective: the harnessing of motor power for snowmobility of men and goods. The first and less inspired school intended to adapt the sledge to the internal combustion engine—put simply, to motorize the sledge. The second and more progressive school already recognized the automobile's potential and strove to make it snow-worthy.

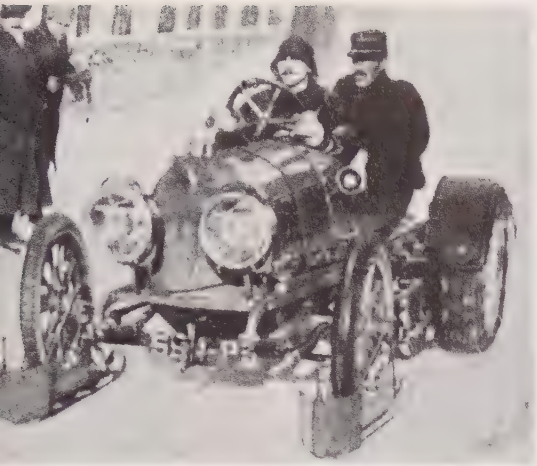
The purpose of these inventions is unmistakably the motorization of sledges intended for travel over

ice or compacted snow. The manpowered tandem sledge on the hill serves only to demonstrate transmission of the motive force to the final drive wheel. Illustrations 3 & 4 are powerboat sledges driven by a large spiked wheel. The front sledge is propelled by an airscrew similar to airships and was much in the minds of technically interested people of the era. The model furthest on the right used an Archimedean screw drive to thread its way through the ice, assisted by a suitably geared propeller. We shall see later that the Archimedes screw plays an important part in snow clearance. *136*

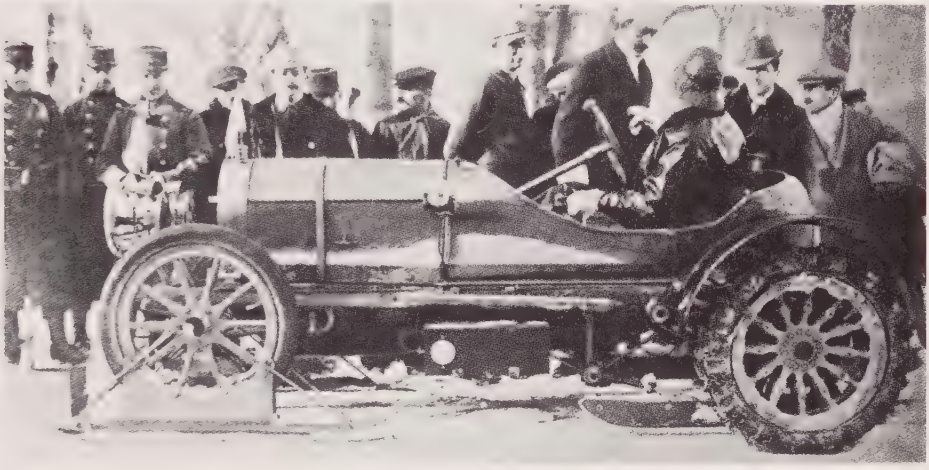
Count de Lissek's propeller sledge, new in 1911, is designed for use on soft snow: the runners are wide and shaped like skis. *137*

Lieutenant Jean de Besse and his snow tractor at Chamonix, 1908. *139*

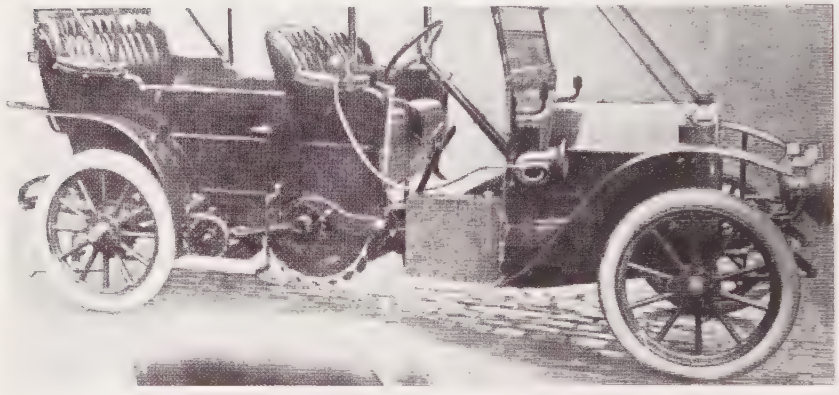
Still basically a sledge, this German machine, 1908 vintage, probably originated in Bavaria, judging by the lady's hat. The coachwork resembles the horse-drawn sledge or carriage of the period and propulsion is by a number of paddle-steamer wheels; once more ship design comes through. The radiator cap—no doubt with Deutscher Adler mascot—is missing. A sign of the times? *138*



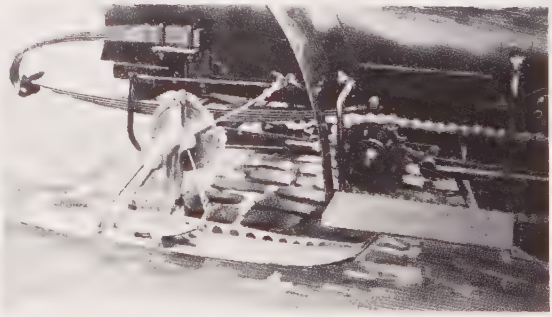
In February 1910 the Touring Club de France organized a competition for automobile sledges in the mountain range of Les Vosges. Here are the winners—First: Legrain in a Rolland-Pilain. A typical sport or racing car layout, modified for use on snow. Ski-type runners with pointed snow plough head are fitted over the front wheels and the much larger rear tyres carry snow chains. What appear to be stabilizing runners are mounted on the chassis parallel with the back wheels. Legrain was one of the few inventors who developed the car for use on snow and succeeded and also designed motorized sledges. *140 and 141*



Nivert in his own propeller sledge came second. It is powered by a 10 hp Anzani engine and weighs only 200 kg. The power to weight formula certainly paid off and the design of this machine leaves no doubt of the builder's faith in the motorized sledge. *142*



By far the most interesting and well-designed vehicle came third. Designed and driven by the French sportsman Lieutenant de Besse, this heavy 30 hp 4-cylinder was available in two forms: either as a normal road touring car with four wheels or with centre traction wheel and four skis, using identical suspension. *143 and 144*



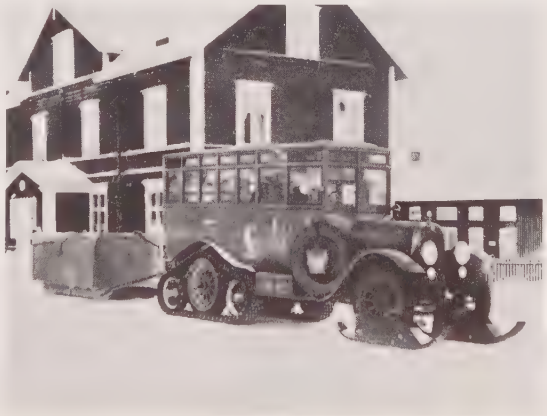
Brake mechanism has been taken over from bobsleigh racing where lever-actuated claws dig into the snow to retard speed. This, assisted by throwing the traction wheel into reverse action, should be fairly efficient to stop the big car. One shudders to think of the consequences if the snow cover is thin and the braking claws scrape the ground at speed. But then, Lieutenant de Besse was a sportsman. *145*

Propeller car: trials by French Government test drivers in Morocco. The 60 hp Clerget engine transmits its power through two chains to a 6-blade propeller. Though net weight is 600 kg, cruising speed is high as the 'lift-push' action of the propeller prevents it sinking into sand or snow. 1914. *146 and 147*

Trials of the René Legrain propeller sledge on the Laureat Pass at 2 075 m altitude. With front mounted two-blade propeller this light sledge was steered from the rear and changes of direction were conveyed from the steering wheel to the rear ski through steel ropes, a method common to powerboats. We have seen this machine in action during Lieutenant Shackleton's South Pole expedition. 1912. *148*

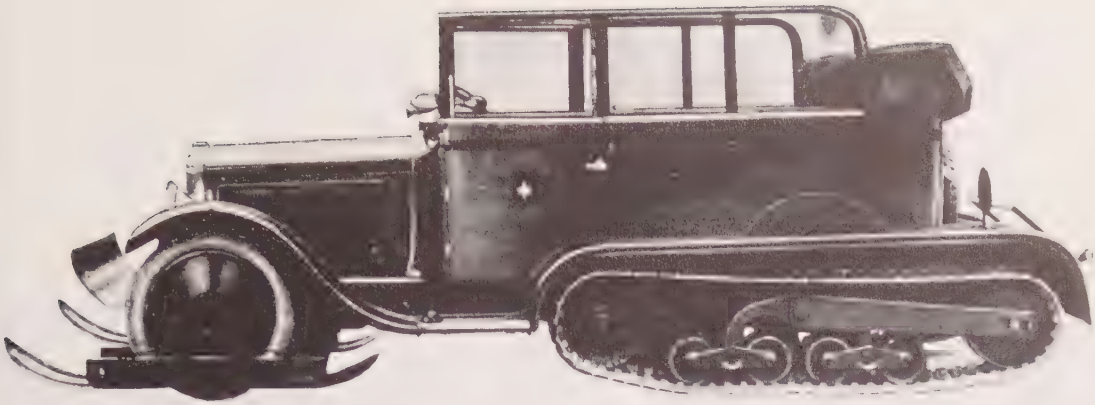
A design far ahead of its time was this wind turbine sledge which was invented by Grand Duke Cyril of Russia in 1911. The turbine or jet was powered by a 35–40 hp Grégoire engine and top speed is reported as 70 km. The front runners are steered. The Jetset will recognize the Grand Duke's flair for design in every Böeing. *149*

To replace husky dogs Frank G Horner of Alaska produced a motorized caterpillar sledge. It was in fact a lightweight version of the tank which had proved itself during the first world war. The driving wheels at the rear are powered by a 22 hp 4-cylinder engine. Change of direction is done through the guide wheel in front, operated by the driver from the back. The guide wheel can be raised or lowered according to the depth of snow. On test this 1921 vintage Snocat reached a speed of 50 km and had a range of over 1 000 km. The chief advantage claimed by the inventor, over the dog sledge, is the vehicle's ability to negotiate crevasses and brooks, and independence from food stores en route. But against this stands the fact that one cannot eat it in case of emergency. *150*



In Europe, road passenger services are usually provided by the postal authorities. The Swedish and, a little later, the Swiss postal administrations were the first to introduce a research programme into the performance of motor-buses on snow covered roads. In 1923 the Swedish Scania-Vabis post bus was fitted with the Nyberg system of rubber tracks and ski runners in front. *151*

In the winter of 1924–5 the Swiss tested the Nyberg track system on Saurer buses in the totally different conditions of the Swiss Alps. On the very steep gradients and narrow winding roads of alpine passes, the new device was not satisfactory without major design changes. These were carried out and in the winter of 1925–6 Nyberg buses were put into service near St Moritz. These buses seated eighteen and were heated. Contrary to expectation, it was still essential to clear roads by snow plough which defeated the objective of Nyberg traction and the service became very expensive. *152*



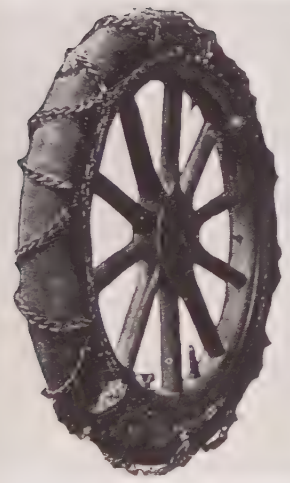
In the middle twenties, Citroën designed their own luxury half-track winter sportscar with wind-down roof, also available in minibus form. But, in common with the Nyberg, it could not get through deep snow without prior clearance. In 1928 tracked buses were withdrawn from active service in favour of wheeled versions. *153*

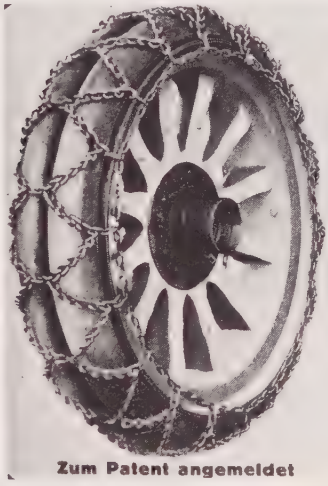
The thorough research of the Swiss postal authority showed the way to the future of snow transport. The wheel would perform well and more economically than all other traction methods, provided the bulk of the snow had been cleared first by the snow plough. Until 1939 wheeled Saurer diesel buses, with ancillary snow plough in front, kept communications going throughout the winter. *154*

The few centimetres of London snow do not worry the Leyland double-deckers, which dominate the London scene. Their low centre of gravity and forward position of the driver's cab combine to provide superb roadholding and visibility. *155*

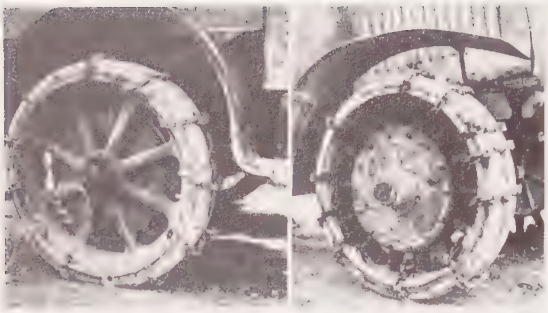
# Chains and ploughs, tyres and blowers

Early descriptions of farm machinery and vehicles already referred to chains and recommended their use for better grip in deep mud. In 1914 the *Automobile Revue* describes snow chain progress in a one and a half page article, 'Automobiles in Ice and Snow'. Two versions are mentioned: the ladder and zick-zack types, galvano-copper plated for rust protection, the pattern being reminiscent of the snow shoe. For the first time the word snow tyre appears in print in an advertisement for Continental tyres. In the USA a gadget is offered in the form of a sand container fitted in front of each of the car's traction wheels. On pressing a switch the electro-magnetic valve opens depositing sand on the road. Obviously the designer took his lead from the railways, where sand had been used for a long time to increase traction between rails and wheels.





Full page advertisement by Ertee Roman Talbot, Berlin, appeared in the European and USA motor journals in 1910, extolling the merits of their patented snow and ice chains. 'Insist on the original Ertee chains—German patent No 147 437. Warning: beware of imitations!'. A letter from Bernard C Day who accompanied Sir Ernest Shackleton in the Antarctic speaks of excellent results 'when ordinarily traction was impossible'. Another letter by Lieutenant Koeppens, chauffeur-mechanic in the 1908–9 New York–Paris Rally relates: 'it would have been impossible to get through the USA and Russia without ERTEE chains'. This most marketing-minded manufacturer also introduced snow chains for solid rubber tyres: 'in use by the London and Berlin fire brigades . . . one million sold in the USA by 1913'. *156, 157 and 158*



French army tests snow chains on Schneider and Panhard & Levassor trucks in 1914. *159*

Progress in snow clearing techniques was slow. Not surprisingly, contrary to the entrepreneurial zest of automobile manufacturers, public authorities were responsible for keeping the roads open. The horse-drawn plough working in Earls Court, London, in 1886 was still used in the European Alps as late as 1925. Again, Switzerland led the way in mechanization by combining the Swedish Nyland rubber-track system with a snow plough. *160*

In countries with mild winters and little snowfall, snow clearance remained primitive. But the scraper blade fitted to a London dustcart in the forties finds it hard going. *161*

Only since the end of the second world war has winter road maintenance caught up with vehicle progress. The gas-turbine high-speed snow blower removes snow drifts from the roadside at Longueuil, Quebec, Canada. The engine is only 1·5 m long, with a diameter of 45 cm, develops 750 hp and weighs a mere 125 kg. The method of clearing the snow is a combination of shredding, pulverizing and then blowing the mass away from the road. *162*

The drivers. *163*

This road in the USSR connects Kirghiz with the city of Osh. It crosses two mountain passes at a height of 3 200 m. Avalanches are common and several sections lead through tunnels. This is one of the very few mountain passes of over 3 000 m kept open to traffic all the year round. Snow clearing teams are stationed at regular intervals and often work at 40° below zero in severe gales. At this particular spot snow drifts of over two metres in height accumulated within twenty minutes. *164*

Snow blower at work in alpine conditions. Special net chains make use of vertical as well as horizontal traction. *165*

Snow clearance in town presents its own problems and during heavy snow falls clearing operations must continue day and night to be successful. *166*

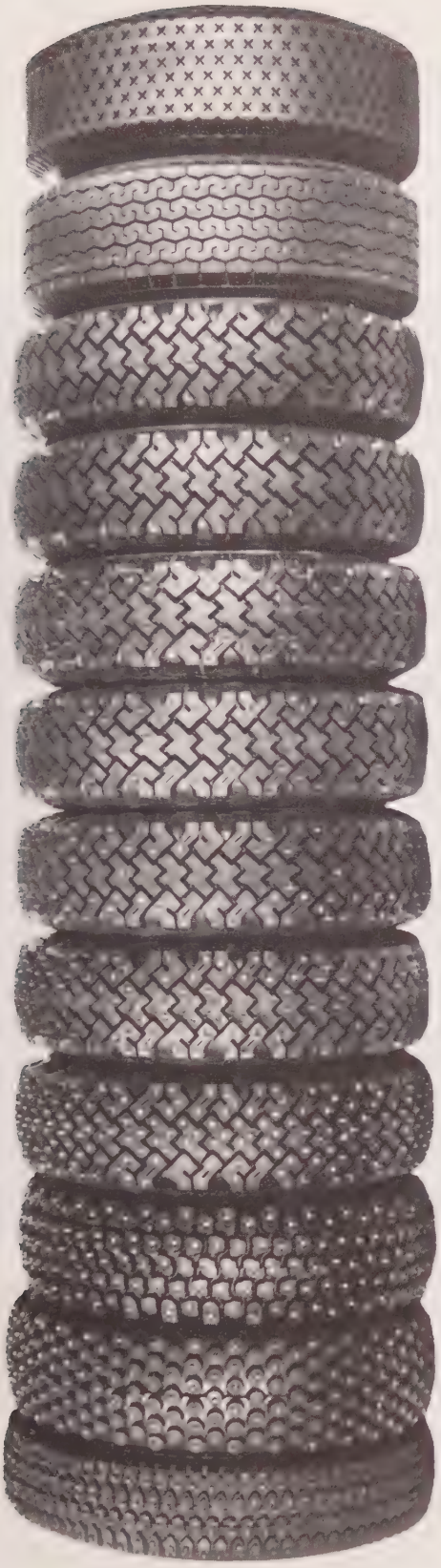
This Russian snow blower uses the Archimedean screw principle for scooping up and then blowing the pulverized snow through ducts into the lorry behind. *167*

In the North Russian city of Sakhalin blizzards brought all traffic to a standstill for five days during the winter of 1970. Wind velocity was up to 40 m/sec and in many places snow drifts were higher than the average winter's snowfall. Normal life came to a halt, while helicopters, ski-planes and snowmobiles kept the city supplied with the essentials for survival. Bulldozer teams began to clear the roads for wheeled traffic as soon as the storm abated. *168*

A familiar sight in Moscow: convoys of snowploughs and lorries dumping the snow into the Moskva river. In some of the vast city squares the snow is dumped straight into the sewer network. *169 and 170*

Where it is essential to remove the snow completely, the snow melter can produce the desired results, but the expense is very high. After melting, the water is run into the sewer system. A practical solution for car parks, factory yards and other vital areas where the method is economically feasible. For airport runways the philosophy of prevention rather than cure, is realized by thermostatically controlled surface heating. In countries with occasional frost and snowfall, many strategic bridges and junctions are surface heated to prevent icing-up. *171*

A glimpse of private snow clearance at Hastings-on-Hudson, USA. In regions where snow falls for four or more months of the year, a motor-powered snow blower is considered as important as the lawn mower in countries where the grass is cut weekly. *172*



Today snow tyres have superseded chains for cars and trucks, except for alpine conditions where chains are still vital. Snow clearance leaves a well-compacted snow surface, often overlaid with a crust of ice. The only way to grip a hard surface is to attack it with an even harder one. Rubber, however hard, will never cut into ice. Alpinists put this principle into practice with the ice-axe. Another early application is the insertion of studs into the under side of horse shoes when horses work on snow and ice. Equipped with these studs the animal can exert considerable traction without losing its footing. Quite recent research work has led to the design of studs for tyres. These are inserted into the tread pattern segments and have proved highly successful on snow and ice. Modern snow clearance has opened winter travel and transport to cars and trucks over the snow-covered roads of the world. Fitted with snow tyres and chains for mountain roads, the wheel can ensure fast, safe and reliable snowmobility where roads exist. *173 and 174*

Road clear. Post bus near Berne, Switzerland. 1970. *175*

# Ski-planes and rescue

On 5th February 1912, René Grandjean, a Swiss pilot, made history in snow travel and transport. Having fitted skis to his monoplane, he made a take-off from the frozen and snow-covered lake at Davos, climbed to 1 600 m, circled a few times and landed safely back on the lake. Afterwards he took many passengers on excursion flights in the region. This was the birth of snow and glacier aviation. Apart from isolated sporting flights, of which flying pioneer François Dufour's wheel landing on the Mont Blanc Massif at 4 330 m is typical, little practical progress was made until after the second world war. In its infancy, snow flying was slow to develop. The reasons were certainly not technological. Aircraft design and powerplanes of the thirties were highly suitable for short take-off and landing essential to alpine flying. The missing link was a snow and ice pilot. A man who loved and understood the white alpine giants, a man who respected and could cope with the sudden blizzards, who could smell the fog before it came down, a man to whom glaciers were as familiar as the runways of Heathrow, John F Kennedy and Sheremetiev airports are to airline pilots. But much more was needed: a man who was many men. A pilot, of course, a navigator and flight engineer certainly, a radio officer and ground crew, a skier, a mountain rescue man and first aid expert. Finally, a man who could make decisions alone and had the confidence to act—a man who could be wrong only once. In Europe in the Valais of the Swiss Alps this man was Hermann Geiger. In the United States of America, in Alaska, it was Don Sheldon. Legendary figures, both of them. *176*

Hermann Geiger. *177*

Glacier pilot Hermann Geiger, born in 1915, was killed tragically in an apron accident at Sion airfield, Switzerland, in 1966. Geiger had the thorough and methodical approach of the true ski-mountaineer. He was determined to evolve a landing and take-off method for glaciers and snow plateaux which could be repeated and taught to others. Stunts did not turn him on. To succeed meant many survey flights and flying costs money. Meanwhile he offered a service to drop supplies to sites normally cut off during the winter. He designed his own carrier and jettisoning device, fitted to a Cessna 170, a plane capable of reaching 6 000 m above sea level. After some practice he could drop materials or food supplies on an area of 10 × 10 metres. During the winters of 1950 and 1951, when the famous Grand Dixence hydro-electric power project was under construction, a group of engineers and workmen were cut off from all communication by avalanches. Geiger dropped mail, food and materials virtually without breakages, although, he writes in one of his reports: 'not always as punctual as I would have liked'. A remark typical of his modesty and sense of duty. All the while he continued to scan and study the glaciers for his ultimate aim: to find a landing and take-off technique.

On one of these missions he discovered a herd of chamois surrounded by six metres of snow. Some of the animals appeared almost completely buried. The noise of his engine drove them frantic with fear and they tried to jump clear to hide in the nearby rocks. He decided to drop some hay during his next flight and his first attempt was successful. Next day the hay had disappeared. He continued to feed them and noticed a complete change in their behaviour: instead of trying to hide, the chamois left their hiding places as soon as they heard the hum of the engine and pointed their small ears toward the roar of the propeller and watched the manna falling from the sky.

The demand on Geiger's services increased. In one severe winter he and a colleague kept Zermatt supplied with food and the essentials of life for a week. They made as many as twenty flights a day when the weather allowed. In the same winter, a shepherd and his flock were caught by sudden heavy snowfalls behind the almost vertical walls of Mont d'Ardevaz, above Leytron. The sudden weather change had forced the shepherd to descend alone and abandon the sheep huddled together on a rock platform sticking out over the valley, like a terrace in the sky. During the night the wet snow froze and in the morning it had turned to sheer ice. The route to the rock was now impassable for man or animal. The shepherd asked for Geiger's help. Sheep are nervous and easily rattled creatures and their rock refuge covered only a few square metres, with vertical rockface on one side and a thousand metres drop on the other. Geiger took no chances. To accustom the herd to his noisy bird he first circled at considerable distance, gradually getting closer until the shy animals understood that there was nothing to fear. After some ten flights the sheep actually followed the plane's movement with their eyes which was his signal to release a few bundles of hay. For five days he plane-fed the flock. When the weather improved Geiger joined mountain guides and farmers in the difficult rescue task. 'They hadn't put on weight,' he relates, 'but all were alive and I left them chewing peacefully in their shed in Leytron.'

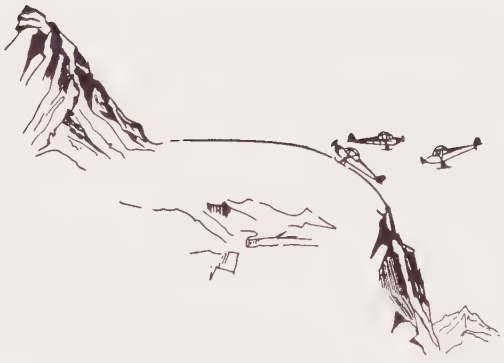
The first glacier landing: Geiger decided to buy a Piper Supercub with a Lycoming motor of 125 hp and equip it with retractable wheels and skis. This was the time when the Swiss Alpine Club started building the Mutthorn Hütte adjoining the Kander Glacier. The mules carrying building materials had caused the contractors endless trouble; they slipped and fell on the icy snow and often showed their disapproval by rolling when their burden flew in all directions. A mule's way of going on strike. The building works of the Mutthorn Hütte required a large quantity of supplies which included breakable items such as windows and ceramic pipes. Dropping these was impossible unless they were packed with great care.

The formation of the Kander, with few crevasses and almost flat, was ideal for the first glacier airport. 'My mind was made up', writes Geiger, 'and I climbed to my future airport many times to explore the surface, often accompanied by a guide, and I took careful measurements. The landing area stretched to within 100 m of the site and in my mind I already saw materials being unloaded from the Piper and stacked near by. In the end I knew the surface of the glacier as well as Sion airfield.' On 10 May 1952, Geiger brought down his plane to a safe landing on the glacier but some distance from the hut. Typical of the man, he took off again and again until he landed close enough to the hut 'to fulfil my contractual obligations to deposit forty-two tons of building supplies within 100 m of the site planned for the erection of the Mutthorn Hütte'.

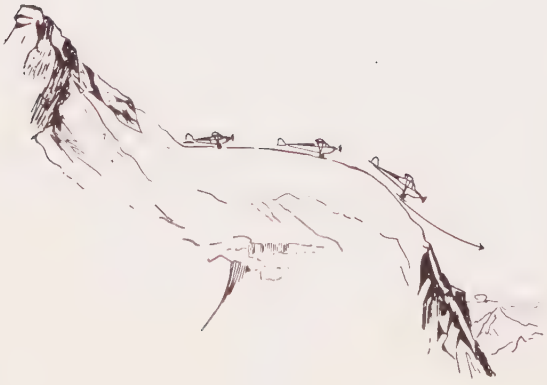
Geiger was overjoyed with his successful first glacier landing and at once contracted to deliver the materials for the extension of the Rossier Hut at the foot of Dent Blanche at 3 500 m, which now bears the mountain's name. Fifteen landings per day were no exception. *178*

Short landing technique by Hermann Geiger, 1954.

Explore surface conditions and air currents, choosing a mark above the level area at which to aim the aircraft. Approach the slope at right angles and land the aircraft up it. Force the plane to climb the slope on full throttle, aiming at the mark and cutting the power as soon as it reaches the level area so that it halts before the far end.



Commercial airports are sited for their ease of approach and departure. If a pilot is in danger of over-shooting the runway, he throws open the throttle, climbs, circles at the correct height and lands. He can repeat this game *ad infinitum* with the certainty of eventual success: rather like an exam which one can sit again and again. In glacier flying, landing conditions change from one minute to the next and previous landings are of little guidance to snow conditions on the next one. The first attempt must be right—there is no second chance. *179*



Short run take-off technique.

Full throttle start with joy-stick pushed fully forward. Still with full throttle and stick forward, follow the ground contours. As soon as there is adequate speed pull back the stick gently and you are airborne. At last you can breathe again: height—distance—space . . . the game is won. *180*

Don Sheldon. American glacier pilot on the Kahiltna glacier. Mount McKinley National Park, Alaska, USA, ready for take-off. *181 above*

Conso aircraft at Deception Island, South Shetlands, GB, preparing for take-off during survey operations. *182*

Speed is the essence of all rescue. Where men are buried in an avalanche the survival chance is minimal after more than thirty minutes under the snow. Once an avalanche dog is on the scene, its speed of tracing the victim is phenomenal. A fully-trained dog will scan a 100 × 100 metre avalanche and make contact with the buried man in 7–9 minutes. Today's electronic search devices take just as long. The skill of the air rescue team is getting handler and dog to the avalanche with the least delay. Herr Erziger and his dog Zita are pioneers of parachuting on snow. *183*

Prior to landing Erziger extends the dog's rope slowly to prevent a collision on touch-down. They hope to come down on the highest point of the avalanche to work from the top down, saving energy and gaining speed. *184*

Since 1954 conferences and courses for glacier pilots are held regularly. Here aircraft and dog practise together as a team. Jungfraujoch, Switzerland 1950. *185*

Forty years passed between Grandjean's first flight with a ski-plane and practical glacier flying. In October 1905, the Dufaux brothers made the first vertical take-off with a freight carrying helicopter, yet almost fifty years elapsed before these snow birds joined the ski-planes in snow aviation. Their speed was slower and initial outlay and running costs higher, but for restricted and pinpoint landing conditions they proved ideal. Geiger operated ski and helibirds side by side. After a diesel oil delivery and re-fuelling near the Matterhorn, the machine is ready for the return journey. *186*

In Siberia the construction of electric power lines continues throughout the year, in close co-operation with snowmobiles. *187 and 188*

In air rescue the helicopter has also superseded parachuting for man and dog but here the narrow clearing does not permit a landing. The rescuer has lowered his equipment first and now follows down with transceiver slung over his right shoulder. *189*

The buried man has been located by the dog and the team begin digging. Meanwhile the air rescue helicopter has been directed to the accident spot by radio and stands by to give first aid and fly out the victim. Swiss Air Rescue was founded by Dr Fritz Bühler in 1952. Today they own several air-ambulances, helicopters and glacier planes, all fully equipped to cope with disasters, air crashes, mountaineering accidents and ambulance work. Since their inception they have carried out over 8 000 sorties in all parts of Europe. *190*

One of Swiss Air Rescue ski-planes has arrived to assist an injured skier. The collapsible Bofor sledge has become standard for work of this type. *191 and 192*

Where neither ski-plane nor helicopter can land, Alouette III takes over. This net has been developed by SAR to transport injured men with particular regard to spinal damage. The victim is held rigid and travels in relative comfort and complete safety, accompanied by the ambulanceman. *193*

SOS call from Eggberg Farm. It is 15.23 hrs and the red helibird of SAR is on its way. On board are pilot Chris Bühler, son of the founder, and Dr Peter Dangel, intensive care specialist, himself a helicopter pilot. 'Ground mist up to 50 m over Eggberg' squawks the radio and also gives a few details of the accident: a mountain farmer was severely injured by a falling tree—son brought him to house on a sledge pulled by the house cow. Mother phoned doctor in nearest village but road to the farm impassable. 15.42 hrs helicopter lands a few metres from farmhouse. The injured man is semiconscious. Examination—transfer to helicopter—transfusion—three minutes flight to the heli-landing pad of Glarus Hospital. It is now 15.51 hrs. *194 and 195*

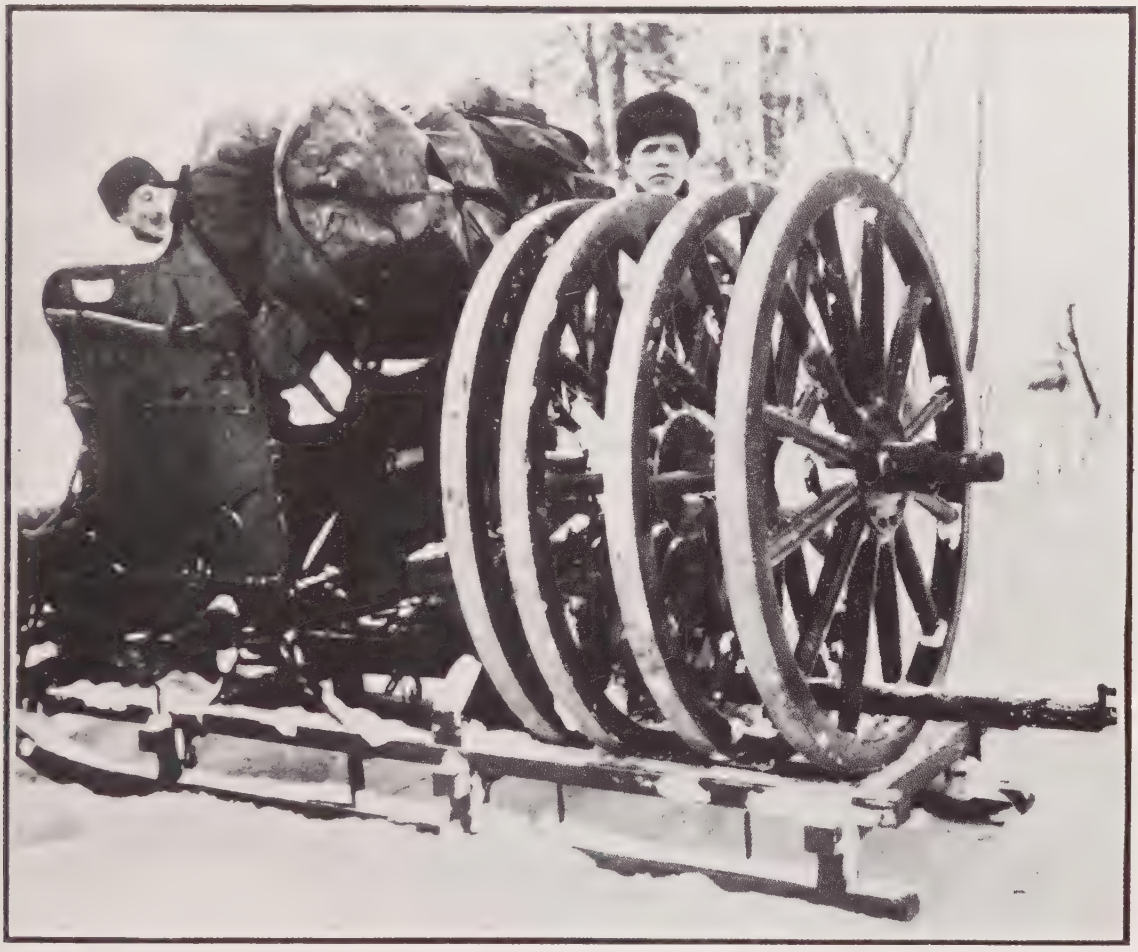
Mobile operating theatre on circuit in the north of the USSR. *196*

After the operation the patient is driven home in a snowmobile and left in the care of a helicopter 'house surgeon' for further supervision and treatment. These flying doctors use the Kamov KA 26 which is jet assisted for speed. *197 and 198*

Translation from the Swiss Air Rescue Annual Report for 1968: ' . . . large avalanches cost twenty-four lives and heavy damage to property. Altogether eight helicopters were in action in various areas. 146 people were evacuated and much material was moved. Our first job was the evacuation of farmer Florian Iten with his mule, two rabbits and one chicken from the Alp Hinter-Tarsana to Seewies in Prätigau. . . . '
*199, 200, 201 and 202*

# War

Man is an aggressive animal and has contrived to pervert much of his ingenuity to war use. Snow travel and transport are no exception. In the thirteenth century ski troops were first in evidence in Norway. Their weapons were bow and arrow. By the eighteenth century some 1 500 ski troops were trained by Captain Jens Emahusen. In 1732 he also produced the first military manual of winter warfare, going into such details as length of skis and rifle practice on skis. Written in German, the military language of the time, 'Skiloperegglement' is available to students of winter warfare in the Oslo Ski Museum. In 1765 a printed version includes hand-tinted sketches of ski drill and demonstrates the kick turn. In 1904 the Russian Army's Medical Corps recovered the wounded on improvized sledges made by joining together several skis. The method has become standard practice in mountain rescue, but I do not recall injured skiers looking quite as smug as the Imperial Russian soldier on the ski stretcher. *203*



Development in any sphere is inclined to work through complexity to simplicity. In the R and D units of any army this maxim prevails *in extremis*. Norwegian horse artillery of 1904 dismantled the ammunition wagon (left) and loaded it on a sledge; the guns are conveyed in like manner and reassembled on site. A German manual on winter warfare (Plate VI) published in the late thirties and still competent during the second world war, shows progress. *204*

During the four winters of the first world war, the fighting armies depended entirely on horse drawn sledges for transport on the Eastern Front. Some 1 000 sledges are amassed near Warsaw for the Kaiser's offensive against Russia and converted field carts take the wounded to front line dressing stations. *205 and 206*

Air-propelled sledge of the Kaiser's Army on Lake Löwentin, Poland. At the left is the Kaiser's youngest son Joachim of Prussia, on the right Colonel Busse. They both look sozzled and no doubt the driver prays for victory. *207*

This is an action photo during General Von Rundstedt's last offensive in the Ardennes, Belgium in 1944. British and USA forces bring back their wounded on sledges made from packing cases. 'I remember laying telephone wires to Divisional Headquarters, using a cow to carry the roll of wire on her back. Artillery fire was active and a shell exploded quite close. The cow stampeded, only to succeed in getting herself and me hopelessly entangled in the wire'. Phone communications were somewhat delayed due to unsuitable snow transport. *209*

British troops with an Austrian two-in-hand sledge at Imst, Austria 1918. *208*

Canadian infantry use snow shoes of the pointed heel type which are similar to those of prehistoric times. The camouflage is very effective in the Norwegian forest during the second world war. *210*

Swiss ski troops on the march. With loads of 25 kg or more, a steady descent rather than speed is essential as loss of balance means a fall. To get up in deep snow with full equipment is time consuming and exceedingly tiring, particularly at high altitudes. To move uphill for any distance, skins with short stiff hair are fitted to the underside of the skis: the hairs resist slipping backwards and even relatively steep gradients can be taken at slow walking speed. Originally seal skins were used for this ancient aid to alpine ski-ing: today the skins are synthetic. According to the terrain and snow conditions, distances between 30–70 km per day with full pack and weapons can be covered. *211 and 212*

Anti-tank gun on a downhill run. *213*

Alpine troops still employ mules to carry ammunition and proviant. They carry up to 90 kg in addition to harness and pack saddle. They are sure-footed and outmarch men. *214*

In less extreme terrain the Bombardier troop carrier now provides reliable and fast transport. *215*

Even the infantry will be self-propelled in the snow. This power pack weighs only 11 kg and allows the skier to move at a speed of 30 km/hr. The engine—a 4 hp 2-stroke design—develops a thrust of up to 16 kg. This is a Russian invention by Feoktist Magin of the Mari Polytechnical Institute 1969. *216*

Fortunately for horses the wars of man are over. After 4 000 years of service, a new species have taken their place. This amphibious propeller sledge serves the forces of the USSR and the air sledge has been adapted for military use by the Canadian army. *217 and 218*

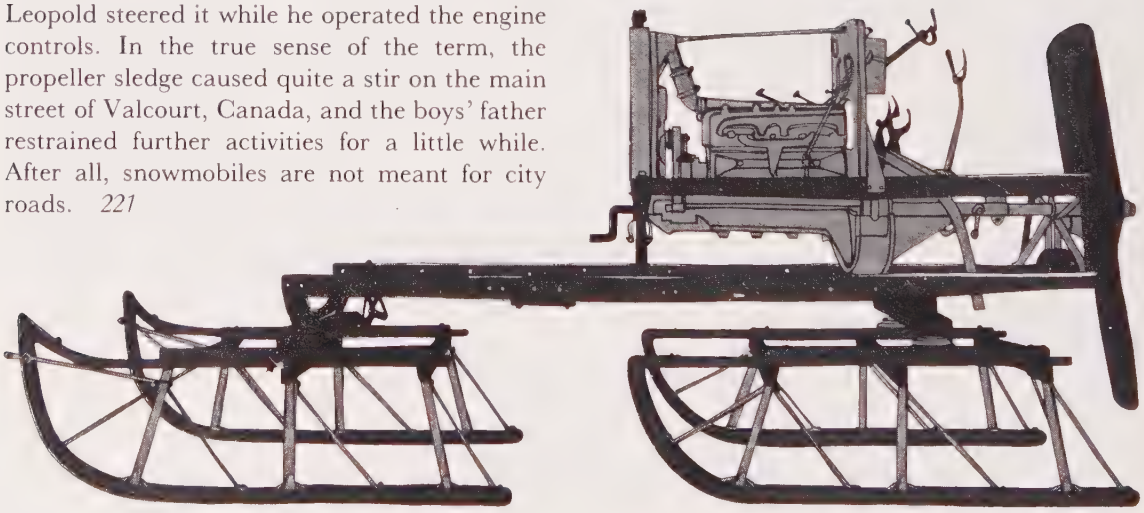
# The horseless sledge

For traversing snow and ice-covered terrain without roads, the wheel is a failure. The weight of the vehicle pressing on the very small contact area between tyre and snow causes the wheel to sink in. Instead of moving forward when traction is applied, the familiar wheel-spin enlarges the hole in the snow and the car sinks deeper. For the people in the north in Alaska and Labrador, in the Northern USSR, Iceland, Greenland and Lapland, there are no roads in the winter. From November until the end of May, for up to 290 days of the year, frozen lakes and rivers and snow covered land form the natural highways for the sledge. In June and October communications over land come to a halt. Napoleon's and Hitler's retreats over the sloshy slurries of icy mud are well-recorded examples. In permafrost areas, all land-mobility stops during the three summer months of June, July and August. Then the slosh freezes, forming deep ruts and sharp ridges and when the snow begins to fall the sledge takes over for snowmobility. Until this generation the men and women of the north relied on vehicles for travel and transport which had not changed basically for over 1 000 years. Snow shoe and ski, reindeer or dog sledge, according to habitat, remained their means of winter mobility.

For some three decades diesel or petrol driven Snocats—the heavies of the north—have carried freight over the glaciers and snow in North America and the USSR. Technically similar to Sir Vivian Fuchs' fleet for crossing Antarctica, they offer reliable and fast commercial transport. These long distance drivers are on the Athabaska glacier, Columbia icefield in Alberta, Canada. For the ordinary traveller, however, the hunter, the herdsman and fisherman, neither aircraft nor surface vehicle was suitable to replace his traditional and economical dog or reindeer-powered transport. *219*

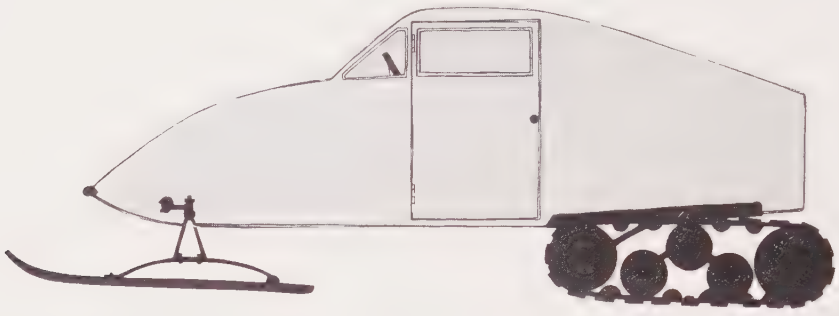
No passengers were carried on this railless tractor-train moving machinery and survey equipment to Byrd Station, Antarctica. It was designed specifically for low ground pressure and this was achieved by exceptionally wide tracks. In some versions the tractor has a power-take-off, coupled to one or more live-track tenders carrying up to 10 tons. *220*

As a boy of fifteen, in 1922, Armand Bombardier made his first horseless sledge, no doubt inspired by Count der Lissek's and René Legrain's propeller sledge and by Casgram's Léon-Bollée ice automobile of 1911. Armand's brother Leopold steered it while he operated the engine controls. In the true sense of the term, the propeller sledge caused quite a stir on the main street of Valcourt, Canada, and the boys' father restrained further activities for a little while. After all, snowmobiles are not meant for city roads. *221*

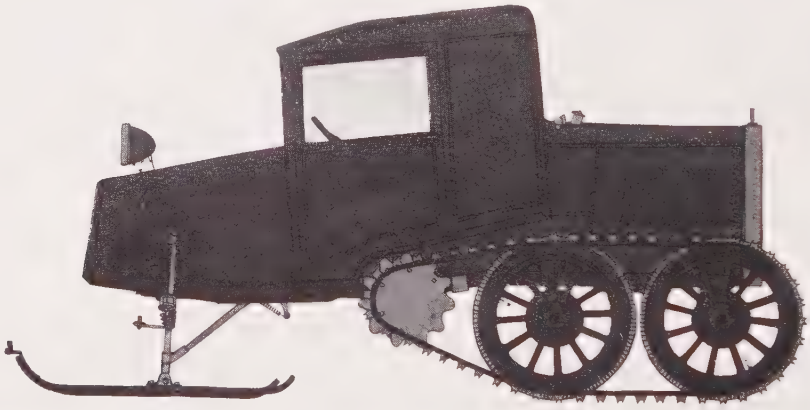


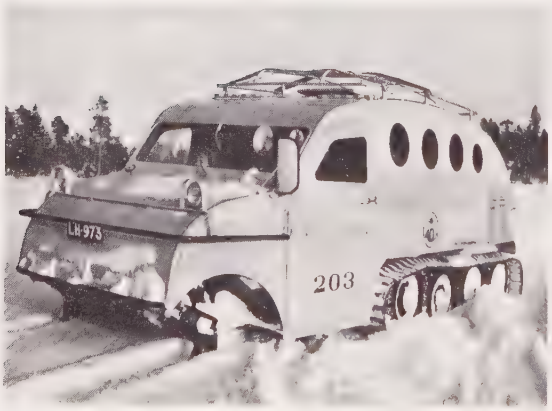
J Armand Bombardier made his first practical horseless sledge in 1927 and produced six of these Model 'T' Ford-based machines. One was bought by an innkeeper who used it to deliver mail and freight to neighbouring towns. Carl Benz's horseless carriage of 1885 became the automobile. Armand Bombardier's horseless sledge became the snowmobile. Both men had been preceded by inventors who made a few 'one-off' moving machines but failed to develop a practical vehicle which could be reproduced in quantity, driven with confidence and serviced in Arctic conditions. Bombardier's sound commercial sense led him to base his early machines on the Model 'T'. He replaced the front wheels with skis, leaving the entire steering linkage intact. Transmission and the original rear axle remained and a second axle was added further forward. Two rubber belts, cross-linked with steel bars, formed the tracks. To this day Bombardier's layout of half-track with frontal ski steering is common to all snowmobiles. *222*

Snowmobile design went through the cycle-car stage in the early thirties. This one was powered by an Indian 4-cylinder motor cycle engine and featured an eight-ply wooden body. The traction pontoon still relied on the car's rear wheel for power transmission but the tyre was omitted. Pairs of steel studs fitted across the well of the wheel engaged with semi-circular wood blocks to rotate the tracks. The wheels and supporting bogies on either side were sprung independently. *223*



In 1935 Bombardier abandoned his quest for a lighter snowmobile and turned to the manufacture of a more solid machine. The engine was a Chevrolet and for the first time sprockets drove the traction unit—a much more positive and reliable approach. Series production had not yet started and demand remained low until the armies of the Allied Forces realized the potential of this versatile machine for snowmobility at the beginning of the second world war. *224*






Meanwhile, Bombardier introduced his commercial go-anywhere chassis which carried a truck or ten-seater bus body. It is still made today in ever-increasing numbers, basically similar to the 1939 design, though looking more sophisticated with age. The traction unit incorporates four bogies mounted on compression sprung arms. (Plate VI). Power is transmitted through a Ford fully-floating rear axle with rubber-faced tooth sprockets. The skis at the front pivot on sprung rocker arms. The 96 hp Ford V-8 engine gives the vehicle a cruising speed of 50–60 kph on compacted snow. *225*

In open terrain the air sledge has held its own. Two men led the field of snow planes in Canada—Carl Lorch and Robert Fudge were the market leaders and produced between them at least 800 of these well-equipped machines from 1929–56. Their limousine bodies boasted heaters and de-icers but the early series did not include a self-starter. Batteries of the day were not sufficiently powerful to turn the engine at −45°: aircraft practice prevailed and the motor was started by spinning the propeller. As road clearance became well established in Canada, the demand for snow planes dropped and they are no longer produced in North America. In Russia, and particularly Siberia, propeller planes are still widely used and their speed equals that of road buses in the flats of the North. *226*

In Kotelby Island in the USSR Arctic region, this heavy snow-truck delivers bulk food to isolated settlements. The residents collect their supplies en route with their own dog team. *227*

In the same way as West European farmers deliver their milk to the dairy company's collecting point, these reindeer breeders from Russian Lapland bring their product to the snow-truck stops of their co-operative. *228*

Work on the Siberian gas trunk line progresses throughout the year. The line starts in Western Siberia and carries natural gas over 2 100 km to Central Russia where it connects up with the Moscow gas ring main. *229*

The Canadian Army Engineering Branch reproduced a sketch in their 'Design Record' showing a toboggan for two passengers. The traction unit consisted of one belt only, driven by an air-cooled single cylinder engine. Power was transmitted in motorcycle fashion through a gearbox and then by chain to a sprocket on the front axle of the wide single track. The toboggan was steered by creating an eccentric drag in bobsleigh racing fashion. The influence of this single track design is seen clearly in the ski-doo, the fast lightweight snowmobile which was first produced in the late fifties. (Plate VI).

Driver Igor Aparov. *230*

The ski-doo is causing social and technological changes in the north, which Professor Pertti J Pelto calls the snowmobile revolution. Several manufacturers compete in this growth market but the Bombardier Company gets the lion's share. Their trademark 'Ski-doo' has become synonymous with snowmobiles. Typical data for these sleek and sporty but hard working machines include a 500–700 cc 2-cylinder motor, 2- or 4-stroke, automatic transmission and reverse. Steel reinforced rubber tracks on independent bogie suspension and disc brakes. Steel chassis and fibreglass cab. Magneto ignition, electric lighting and starting. Tank capacities aim at a cruising range of 150 km. This is the people's car of the north, born in 1958. (Plate VI). *231*

Two or three trips to the trading posts are undertaken by the Lapp families every year. These wholesale centres are usually situated a few kilometres inside the borders of Scandinavia or the Soviet Union, a minimum distance of 120 km from the winter villages. The herders sell reindeer meat and buy household stores. 120–150 kg was the average load for each reindeer sledge and each household used at least four sledges per trip in pre-snowmobile days. Seven geldings and a stand-by animal hauled the sledges. The trip took three days each way. Loading and harnessing the equipage occupied three hours, resting and feeding en route and bedding down at night took another three hours. The ski-doo hauls one sledge with 600 kg payload and the journey takes only five to six hours. The first ski-doo arrived in Lapland in 1960 and today—in 1977—even the most conservative breeders have abandoned their reindeer transport. *233*

Cruising speed on compacted snow is 35 km/h. Frozen lakes and rivers permit fast travel and on bumpy cross-country routes speed may have to be dropped to 6–10 km/h. Most ski-doos provide a small platform for carrying goods behind the driver with a capacity of 200 kg but on long trips these are rarely used; space is needed for a passenger and a freight sledge is trailed. Lapps have evolved their own style of driving. They either kneel on or stand astride the seat. Driving in a standing position gives maximum control and visibility. A less obvious advantage is the improvement in road-holding and manoeuvrability over rough terrain. The driver balances the machine by shifting his weight and rocking from side to side, a successful method used for years in motorcycle racing. Sitting on a snowmobile for long hours over rough country has produced spinal injuries and slipped discs have become associated with ski-doo driving. *232*

Where logs are the sole source for heating and cooking, a family of five to six requires a minimum of twenty cubic metres of firewood per year. During the summer months wood hauling is very difficult for any distance and with the first few snowfalls fuel transport becomes a priority. *234*

In countries where cattle can winter out, the snowmobile facilitates hay distribution in the paddocks. When the ground thaws and the snow turns to mud, the front ski is exchanged for a wheel with a low pressure tyre, more suited for these conditions. *235*

Development continues: the amphibian air sledge designed by Andrei Tupolev, USSR, is a truly universal snow, ice and water vehicle. Payload is 650 kg, alternatively up to six passengers can travel. The small aeroplane engine develops 260 hp and maximum speed is 120 km/h. Aircraft type steering has resulted in excellent manoeuvrability. *236*

The Gorky Polytechnic and the Automobile Engine Research Institute were responsible for the development of the Soviet ski-doo. Inventive genius is greatly encouraged in the USSR and the youngsters are experimenting with a three-ski air sledge built from motor cycle parts. This may well be the prototype of the ski-doo of tomorrow. *237*

# Snowmobility

Since my childhood I have roamed the glaciers and winter mountains. Even in the army during the second world war, I was lucky enough not to miss out altogether. An order went up asking for skiers and I was sent on a few months' detachment to the Grampian mountains in North Scotland, from my 6th Airborne Division. To teach soldiers ski-ing and to survive in snow holes and igloos, experimenting with Eskimo dogs and sledges, was more like a holiday than a duty. The instructors were given the option of leading their platoons up into the snowfields of the training area and returning to base at dusk; the alternative offered a four-week term of living out in the snow, followed by a weekend leave as a bonus. Naturally, I grasped this once in a lifetime opportunity, to relive some small part of the early Siberian hunter's life. As it turned out I lived in a snow hole for almost three months. We dug these two-room apartments into a huge snowdrift. The front entrance, facing south, was of crawling height and blocked against the blizzards from the inside. The communicating opening to the kitchen and cold store was comfortably higher. Both dome-shaped snow caves were ventilated through an opening in the ceiling. We joined together our ski sticks and poked them through the ventilator as a marker in case our snow cave collapsed. The snow apartment house was shared by other crazy types, mostly Norwegians and Poles, not to forget two Eskimo bitch packs who slept happily outside, with their backs to the wind.

When the trainees from the Lowland Divisions arrived in the morning, the Norwegians instructed on sledge dog and dog sledge management and we others taught them to ski in army style. The sledge teams fetched the necessities of life from base. Eighteen Eskimo dogs—two teams of eight with a leader each, consume 18 kg of meat a day and meat was in short supply during the war. We, therefore, decided that deer stalking should be included in the programme of 'survival techniques in winter warfare' and declined further meat deliveries from stores. Though not ideal our sten guns proved adequate. I remember receiving a message from a worried quartermaster who thought we were on hunger strike. As a reply I despatched to him a copious supply of venison steaks by husky express. A week later came an unusually polite flash from Divisional Headquarters ordering 10 kg of best cut venison, suitable for officers of general rank. The North Siberian hunters were in business. We lived well. The Poles converted my Cona Glass coffee maker to a highly-efficient still which bubbled and steamed on a 24–hour cycle, extracting a high percentage schnapps from potato juice. The still room was one of the few snow holes which did, in fact, fall in because of overheating, leaving the ski stick and the Polish standard as a sad marker of these activities.

Skis and dog sledges were our sole means of travel and transport, indeed of survival during these three months.

For the people of the far north, snowmobility equals life. They have been herdsmen, huntsmen and fishermen long before history was recorded. They still are today. For 4 000 years the snow shoe and ski, the dog and reindeer sledge have been their only means of travel and transport. In 1960 the snowmobile began to replace the reindeer and dog for pulling the sledge. Today, seventeen years later, the snowmobile take-over is complete. This is why I decided to write this book: an epoch has come to an end.

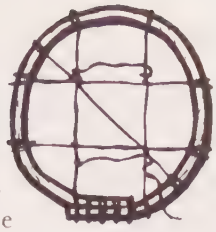
November, 1977

Walter Lorch

# Plate I

## SNOW SHOES

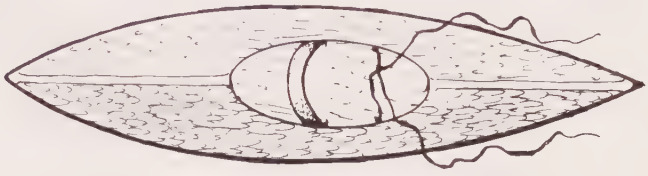
Wood plank type



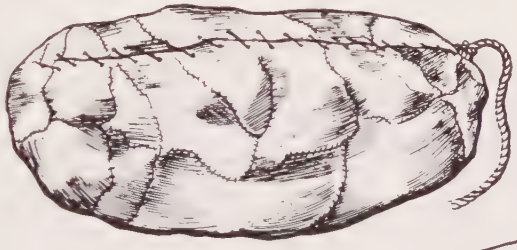
Frame or basket type

Horse snowshoe

Boat type

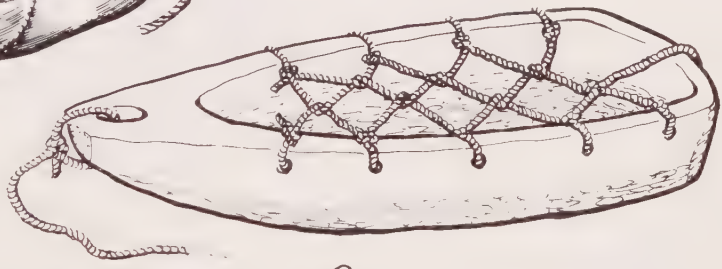


## PREHISTORIC SLEDGES

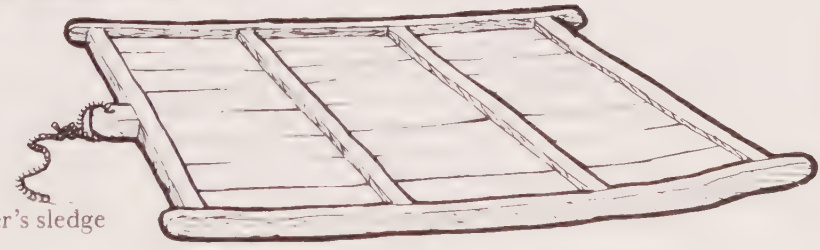


Skin sledge—Lapp

Hollowed tree trunk sledge
Samoyed or Ostyak

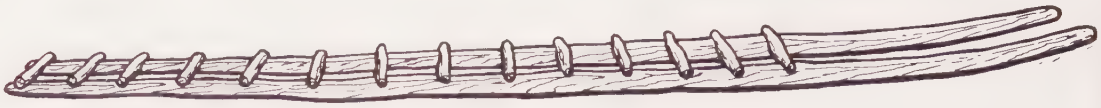


Hunting or boat sledge

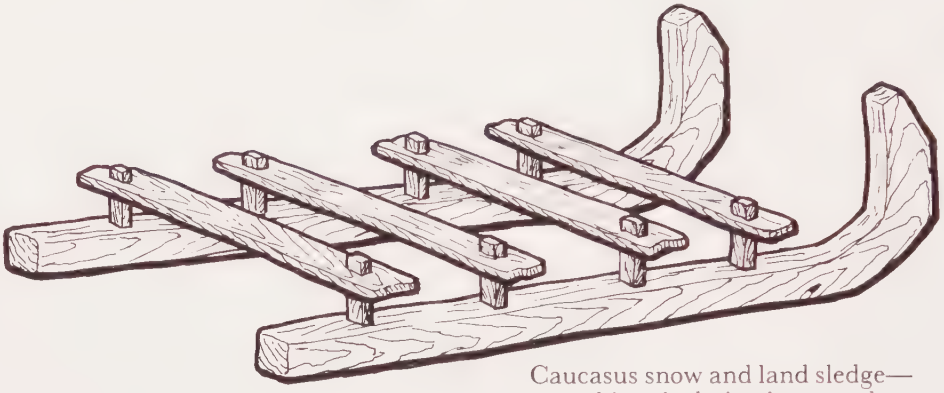


Seal-hunter's sledge

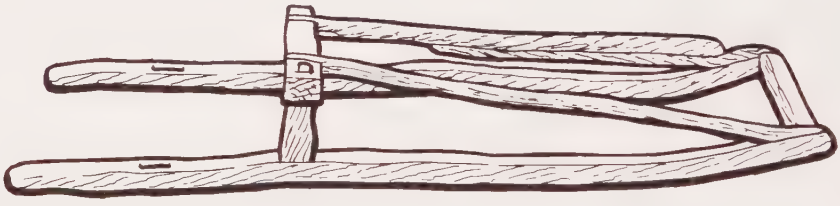
# Plate II



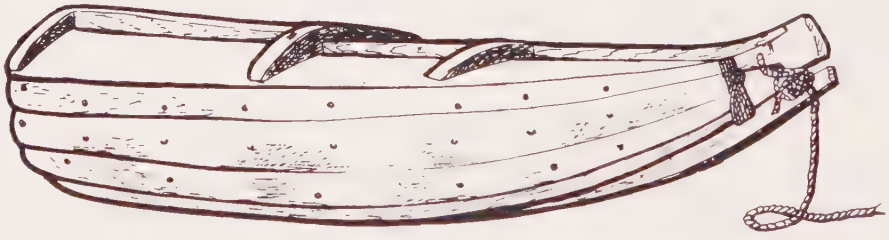
Eskimo sledge—original design for the KOMATIK



Caucasus snow and land sledge—
a prehistoric design in use today

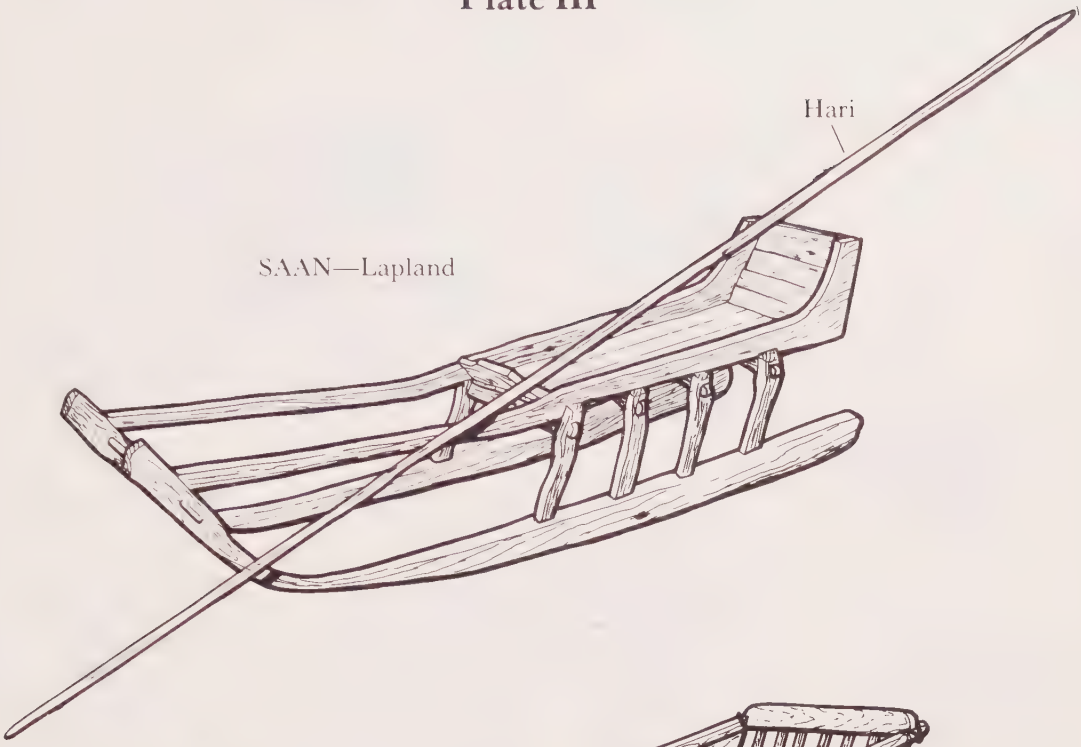


TAKAKELKKA Lapp sledge 1964

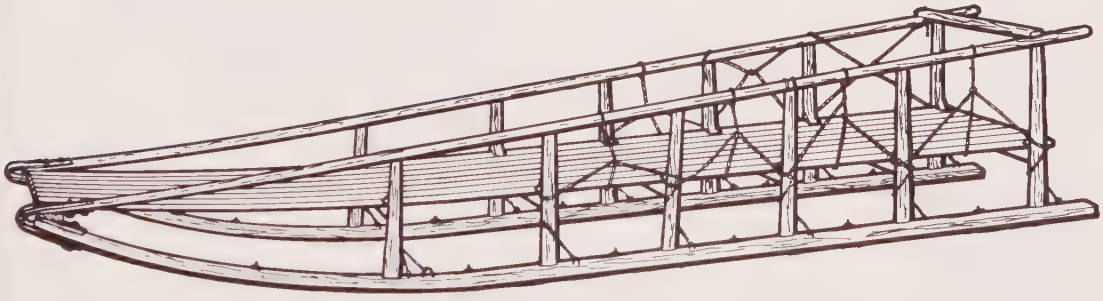


Single runner boat sledge: PULKKA—LAPP

# Plate III



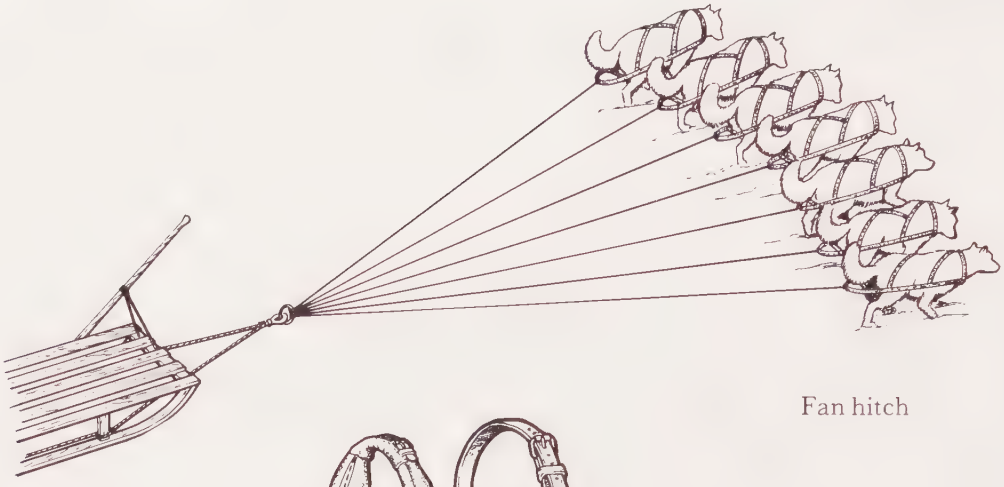

KOMI type sledge with shafts



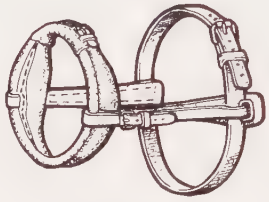
Advanced type built-up sledge

# Plate IV

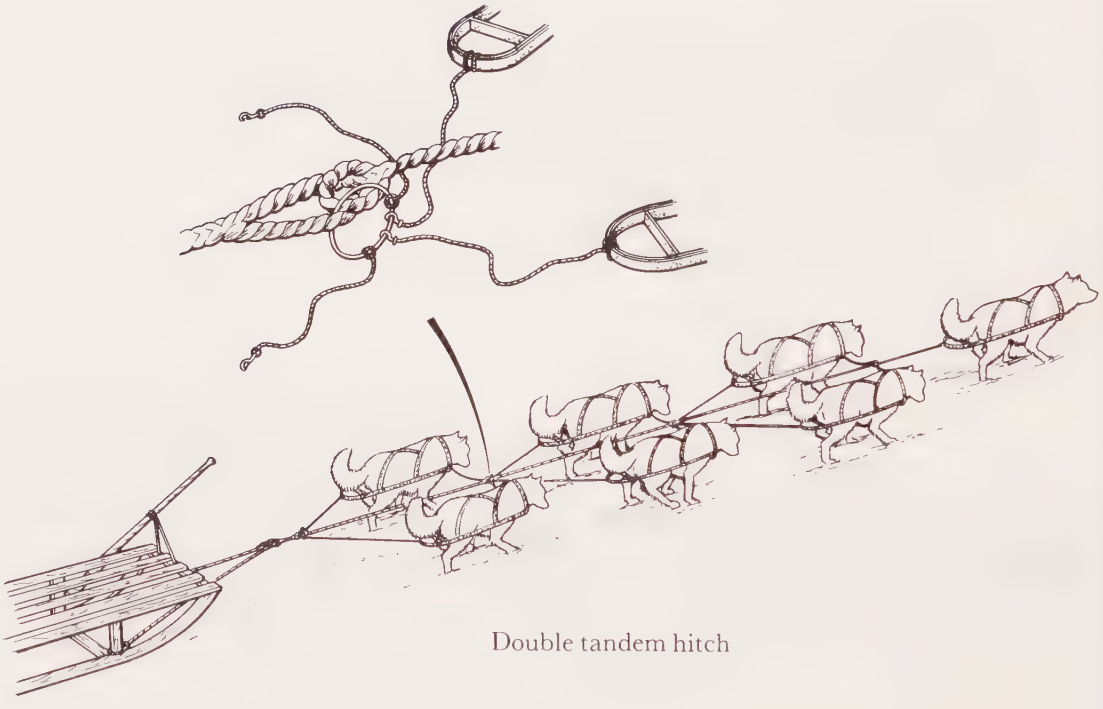
## DOG HARNESS



Fan hitch



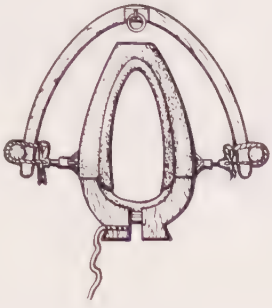
Bridle or harness



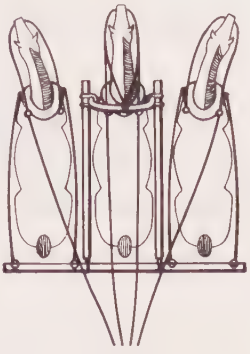
Double tandem hitch

# Plate V

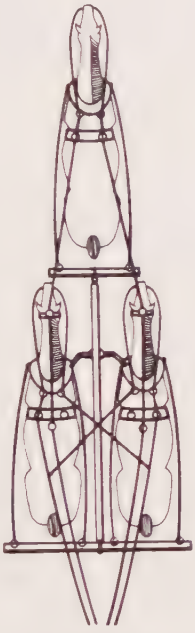
## HORSES



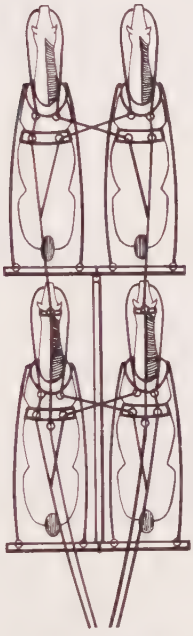
Douga



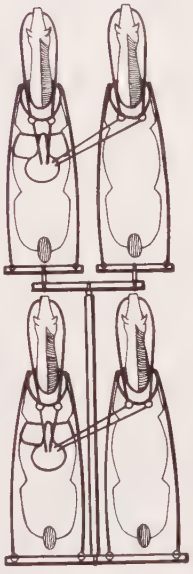
Troika



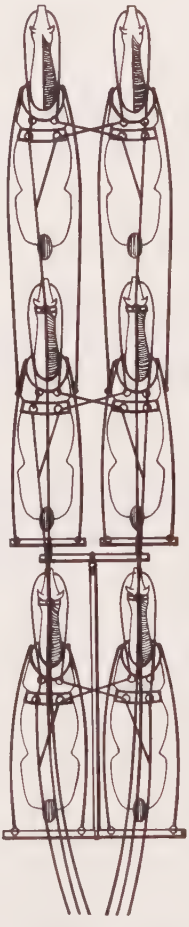
Team of three



Four-in-hand
(long bar)

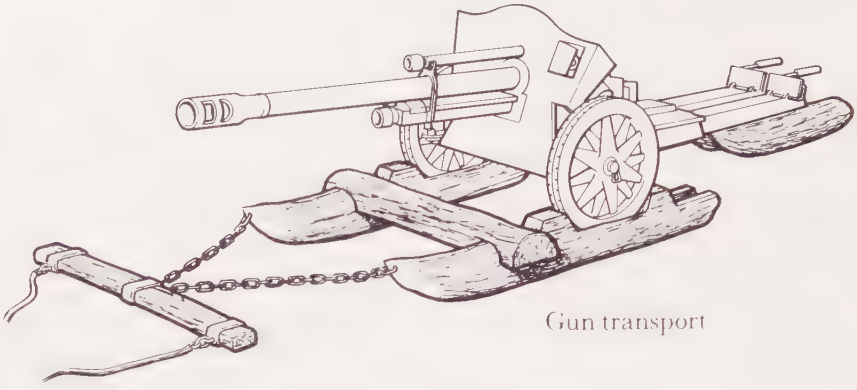


Four-in-hand
(set of bars)



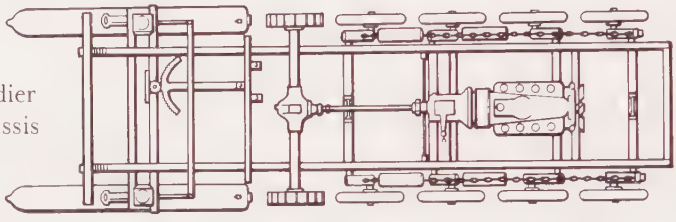
Six-in-hand

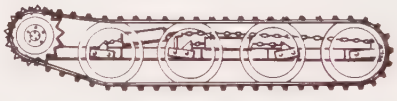
# Plate VI



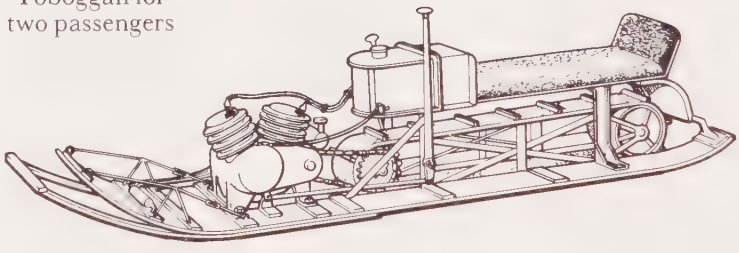
Gun transport

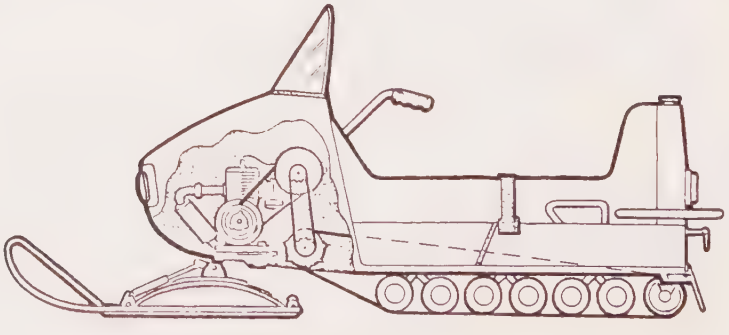
Bombardier
truck chassis





Toboggan for
two passengers





Today's Ski-doo

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# Photocredits

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Automobil Revue, Switzerland, 110, 140–148, 156–159

Barnabys, 56, 57, 59, 62–64, 88, 89, 171, 172, 219, 220, 233

Bombardier L Tée Limited, 221–224, 234, 235

British Antarctic Survey, 123–132, 134, 182

Canadian Forces photo, 210, 215

Carta Marina, 2

Der Glettcher Flieger, 179, 180

Der Schneehase, 1974 Obholzer De Clivo Press, Switzerland, 32

Deutsches Museum, München, 7, 17, 23, 54, 66, 70

Dominion Museum, Wellington, NZ, 118

Dunlop Tyres, Great Britain, 173, 174

Durnford, Hugh, 226

Erlau, Germany, 165

Fliegen Retten Helfen, 176, 183, 184, 189

Ford Archives, USA, 222

From Paris to Pekin, 6, 15

Geiger, H, 177, 178, 185, 186

Historia om de Nordiska Folken, 3

Illustrated Newspapers Group, 9, 13, 19, 26, 78, 79, 82, 83, 87, 96, 100–103, 109, 135, 136, 139, 150, 203, 204

Ilta-Cirkka Lehmusvaara, 46

Imperial War Museum, Great Britain, 208, 209, 218

Information Canada Photothèque, 162

Itkonen, T, 38

Kuznetsov, A, 29–31

Lemercier, Paris, 4

London Transport, Great Britain, 155

Mäkinen, E, 8, 49

Mansell Collection, 5, 16, 27, 28, 33, 36, 51, 53, 60, 61, 69, 71, 76, 85, 86, 138

Marttila, T, 42

Mayer, Ilse, 194, 195

National Motor Museum, Beaulieu, Great Britain, 122, 151

Nickels, 8, 52

Nickul, K, 25, 37, 39–41, 43, 44, 47, 48, 50

Novosti Press, 90–93, 97, 98, 133, 163, 164, 166–170, 187, 188, 196–198, 216, 217, 226–232, 236, 237

PTT Museum, Berne, Switzerland, 10–12, 14, 73–75, 152, 154, 175

Radio Times Hulton, 21, 34, 55, 67, 68, 80, 81, 84, 99, 107, 108, 116, 137, 160, 161, 205, 206

Rhatische Bahn, Switzerland, 106

Schweizer Turn und Sportmuseum, 20, 22, 24, 35, 58, 72, 77, 117, 149, 207

Schweizerische Rettungeflugwacht, 190–193, 199–202

Scott Polar Research Institute, Cambridge, Great Britain, 212, 225

Shell Photographic Service, 119, 120

Ski Museum, Oslo, Norway, 1

State Historical Museum, USSR, 65

Stettler, H P, 181

Swiss Army photo, 211–214

The Heart of the Antarctic, Shackleton, 111–115

To the Great Ocean, 95

Transport and Communications Museum, Switzerland, 104, 105

Valonen, N, 45

# Index


Airborne stretcher, 120
Air rescue, 116
Air sledge, 139
Alaska, 48
Alaskan Eskimo, 45
Alaskan Highway, 48, 49
Allied Forces, 125
Alpine Troops, 131
Alps, 15
Ambulance helicopter, 120
Ambulance sledge, improvized, 121
Amphibious sledge, 143
Animal rescue, 177
Animal skin, 23
Angara, 66
Antarctic, 73
Antarctic Expedition, 75
Antarctica, 77
Antique sledges, 24
Archaeological finds, 16, 33
Archimedes screw, 91
Arctic Circle, 16
Arctic Ocean, 86
Ardennes, second world war, 130
Armstrong & Company, Limited, W H, 65
Army sledges, 125
Arrol-Johnston, 76
Artillery snow transport, 127
Asia, 30
Austin, Captain H T, 73
Austria, 28
Avalanche dog, 116
Avalanche rescue, 119

Baikal, 65
Baikal icebreaker, 66
Bavaria, 51
Beer transport, 28
Benz, Carl, 137
Berg, Göster, 23
Bernina Line, Switzerland, 72
Blinkers, 60
Boat sledge, 33
Bog finds, 23
Bombardier, Armand, 136
Brake mechanism, 94
British Antarctic Expedition, 78
British Antarctic Survey, 79
British Columbia, 57
Bruemmer, Fred, 48
Buhler, Chris, 121
Buhler, Dr Fritz, 119
Bulldozer, 106

Camel, 31
Canada, 33
Canadian infantry, 130
Canadian mail, 54
Canterbury University, New Zealand, 86
Caribou, 33
Caribou hunting, 60
Carrying capacity, 48
Carta Marina, 15
Caterpillar sledge, 97
Caterpillar track layer, 67
Caucasus, 32
Cessna, 112
Chevrolet, 138
China, 26, 27
China, Emperor of, 26
Circumbaikal Loop, 65
Citroën, 99
Clerget engine, 95
Collapsible sledge, 27
Columbia icefield, Canada, 135
Commercial snowmobile, 135
Competitions, 93
Crevasses, 79
Cross-country ski, 18
Cyril of Russia, Grand Duke, 96

Dangel, Dr Peter, 121
Darby, John, 86
de Besse, Jean, 92
Definition 'Sledge', 23
de Lissek, Count, 92
District nurse, 44
Dog, 45
Dog harness, 46
Dog team, 117
Donkey, 62
Double tandem hitch, 46
Douga Plate V, 69
Dragline, 23
Dresden Heidebahn, Germany, 89
Driving technique, snowmobile, 142
Dual purpose sledge, 28
Dufaux, 118
Dufour, François, 111

Eggberg Farm, 121
Emergency feeding, 112
Emperor Penquins, 86
Engine, snowmobile, 136
English improvization, 26
English mail, 56
Eskimo, 15, 45
Eskimo sledge, 48
European Alps, 19, 33
Expeditions, 73

Fan hitch, 46
Feeding dog, 48
Ferguson tractor, 85
Ferries, 66
Field trials, snow tractor, 79
Finland, 33
Ford, Henry, 89
Ford, Model T, 89
Franklin, Captain John, 74
Franklin, Lady, 74
Freight sledges, 56
French Landes, 19
Friction, 39
Fuchs, Sir Vivian, 81, 135

Garratt, Arthur, 81
Gas trunk line, 140
Geiger, Hermann, 111
Glacier landing, 113
Glacier landing technique, 112
Glacier take-off, 111
Glacier take-off technique, 112
Gnat, 86
Gotthardbahn, 71
Grandjean, René, 111
Granlund, E, 23
Greenland, 33, 47
Grégoire engine, 96
Ground pressure, 85
Guide runners, 23
Guide wheels, 97

Hamilton, Belton B, 79
Hari, 33, 34
Harness, 33
Harness, Reindeer, 33
Hasslaur, Victor, 81
Hazards, 54
Helicopter, 118, 119, 120, 121
Helicopter evacuation, 120
Helicopter operating theatre, 122
Herding reindeer, 38
Herdsmen, Reindeer, 37
High Asia, 30
Himalayas, 30
Historia om de Nordiska Folken, 23
Holland, 28
Horner, Frank G, 97
Horse, 51
Horse sledge, 51
Horse snow shoe, 15
Huskies, 74
Husky breeds, 45
Husky team, 48, 84
Hydrography, 66

Ice bicycle, 21
Icebreaker, 66, 86
Ice chains, 101
Ice-fishing, 61
Ice sledge, 25
Ice tyring, 39
Improvized sledge, 27
Indian skin sledge, 46
International Harvester tractor, 85
Inventions, 89

Japan, 15
Jenness Diamond, 46
*John Biscoe,* Research Ship, 86

Kander Glacier, 113
Kayak, 47
King William Island, 74
Kite sledge, 73
Kkamassin Tribe, 17
Kolimar River, 45
Komatik, 46, 47
Komi, 42
Königsee, 26

Labrador, 15, 48
Lake Baikal, 65
Langlauf, 6
Lapland, 15, 16, 28, 33
Lapland trading post, 142
Lapp hunters, 34
Lapps, 33
Leader dog, 46
Legrain, René, 95
Lenin icebreaker, 86
Lichen, 44
Line clearance, 68, 70
London, England, 58
London Transport, 100
Ludwig II, 51

Mail delivery, 20
Mail service, 43
Mail teams, 45
Maize crusher, 77
Malamute, 45
Man hauling, 23, 73
Matterhorn, 118
Melville Island, 73
Migration, reindeer, 33
Moscow snow clearance, 106, 107
Moss, 38
Motorized sledge, 90
Motor power, 89
Motor sledge, 89
Mountain Lapps, 33
Mule, 132
Mürren, Switzerland, 62
Musher, 46
Muskeg, 85
Muskox hide, 48
Mutthorn Hütte, 113

New Brunswick, Canada, 60
Newfoundland dog, 50
New York, USA, 56, 59
Nimrod, 75, 78, 81
Njöll, 37
North America, 33
North Pole, 76
North Siberia, 18, 53
North West Passage, 74
Norway, 15, 33, 79
Norwegian horse artillery, 127
Nyberg system, 98

Ob, 17, 64
Olaus Magnus, 15, 23
Omnibus, 52
Omsk, 31
Operating theatre, air mobile, 122
Ostyak, 45
Oulu, 36
Oxen, 29

Pack saddle, 132
Paddle steamer sledge, 92
Parachuting, 116
Peat, 39
Pelto, Professor Pertti J, 142
Performance, snowmobile, 138
Permafrost, 65
Permafrost, Institute of, 65
Permafrost technique, 65
Piper Supercub, 113
Polar builder's shovel, 85
Ponies, 77
Postal authorities, Sweden, 97
Postal authorities, Switzerland, 97, 99
Post delivery, 20
Power line construction, 118
Prehistoric finds, 23
Prehistoric remains, 45
Prince Albert, 58
Propeller car, 95
Propeller sledge, 78, 92, 93, 95, 134
Prototype snowmobile, 144
Pulkha, 42
Pulkha construction, 42

Quebec, Canada, 61
Queen Victoria, 58

Raide, 40
Rail bridges, 64

Rail laying, 64
Rammers, 68
Reindeer, 16, 33, 35, 36, 37, 38
Reindeer bull, 40
Reindeer cow, 40
Reindeer husbandry, 33
Reindeer ridden, 33
Reindeer sledge, 39, 40, 41
Rislareki, 38
Ritual graves, 33
River trails, 42
Rockface carving, 15
Rödöy Man, 15
Roland-Pilain, 93
Romanov, 54
Ross Island, 78
Royal Mews harness, 58
Russia, 51
Russo–Japanese War, 67

Saan, 39
Sail sledge, 73
Samoyed, 17, 24, 36, 45
Samoyed Husky, 45
Sand spreaders, 101
Saurer bus, 98
Sayan Mountains, 17
Scandinavia, 15
Scania-Vabis, 97
Schwatka, Lieutenant G, 74
Scott, Captain, 79
Scott, Mrs, 79
Seal hunters, 48
Shackleton, Lieutenant Sir Ernest Henry, 76
Shafts, 38
Sheldon, Don, USA, 111, 115
Siberia, 13, 18, 33, 118, 139
Siberian Husky, 45
Siberian tribes, 15, 36, 45
Single tandem harness, 48
Sion airfield, 113
Ski, 15, 16, 18, 21, 135, 137, 138
Ski-doo, 141
Ski-jöring, 33
Ski-plane, 111, 118
Ski troops, Swiss, 125
Skin sledge, 147
Sledge runner maintenance, 39
Sweden, 42
Sweden's Geological Survey, 23
Snocat, 81, 97, 135
Snow bicycle, 21
Snow blower, 103, 104, 105
Snow bus, 98
Snow chains, 101, 102
Snow clearance, domestic, 102
Snow clearance, high altitude, 104
Snowmobile, 118, 123, 136, 142
Snowmobile bus, 138
Snowmobile takeover, 145
Snowmobile transport, 135, 142
Snowmobility, 145
Snow plough, 106
Snow plough, bus-mounted, 99
Snow plough failure, 68, 69
Snow plough, rail, 68, 69, 70
Snow shoe, 15
Snow shoe climber, 18
Snow thrower, 71
Snow tractor, 79
Snow tyres, 101, 109
Snow-velo, 22
South Pole, 75, 78, 85
Soviet icebreaker, 86
Spitzbergen, 33
Sprocket drive, 138
Status transport, 50, 57
Steering, snowmobile, 136
Stockholm, Sweden, 59
St Petersburg, 36, 52, 53
Survey flights, 112
Svanetia, 32
Swiss air rescue, 119, 120
Swiss Alps, 20
Swiss mail, 55

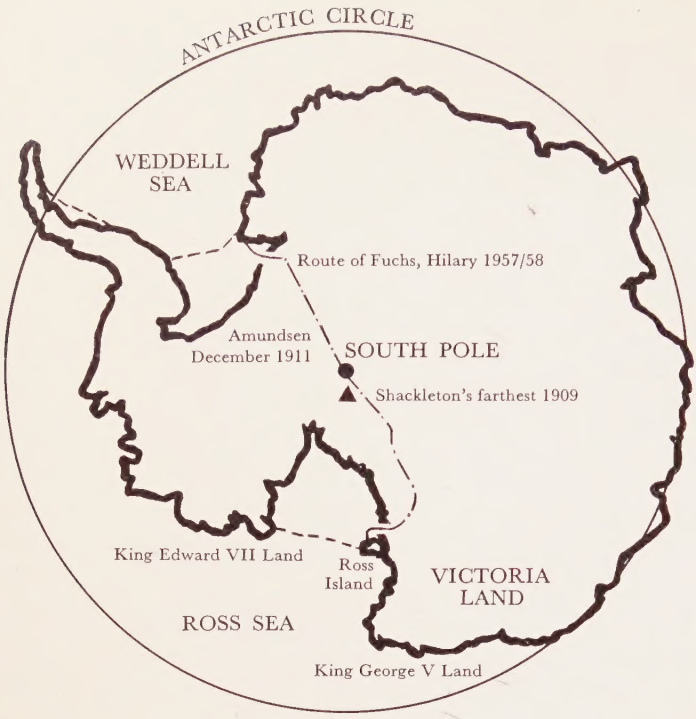
Tegernsee, 25
Tender sledge, 136
Tibet, 30
Tiller steering, 78
Track laying, 64
Traction, snowmobile, 135, 136
Traction wheel, 76
Tractor train, 136
Train ferry, 65
Training horses, 57
Training sledge, 57
Tramway, 89
Tramway sledge, 89
Transmission, snowmobile, 137
Transport for condemned, 23
Trans-Siberian Railway, 63, 64, 67
Trapper, 48
Travel distances, 54
Travel speeds, 45, 46
Travoise, 23
Troika, 52
Troika harness, 53
Troika reindeer, 36
Troika taxi, 53
Truck sledge, 56
Trucker corporation, 82
Two-in-hand sleigh, 58
Tyres, sledge, 39

USSR, 33

Votiak, 18

Walrus Tusk, 39
War, 125
Warsaw, 128
Waxing, 39
Whalebone, 39
Winter feeding, snowmobile, 143
Winter village, 38
Winter village, Lapp, 34
Wolseley snow tractor, 79
Wolseley Tool and Motor Car Company, 79
World war, First, 128
World war, Second, 127, 138

Yak, 30
Yenisey, 17
'Y' sledge, 23
Yurak, 17

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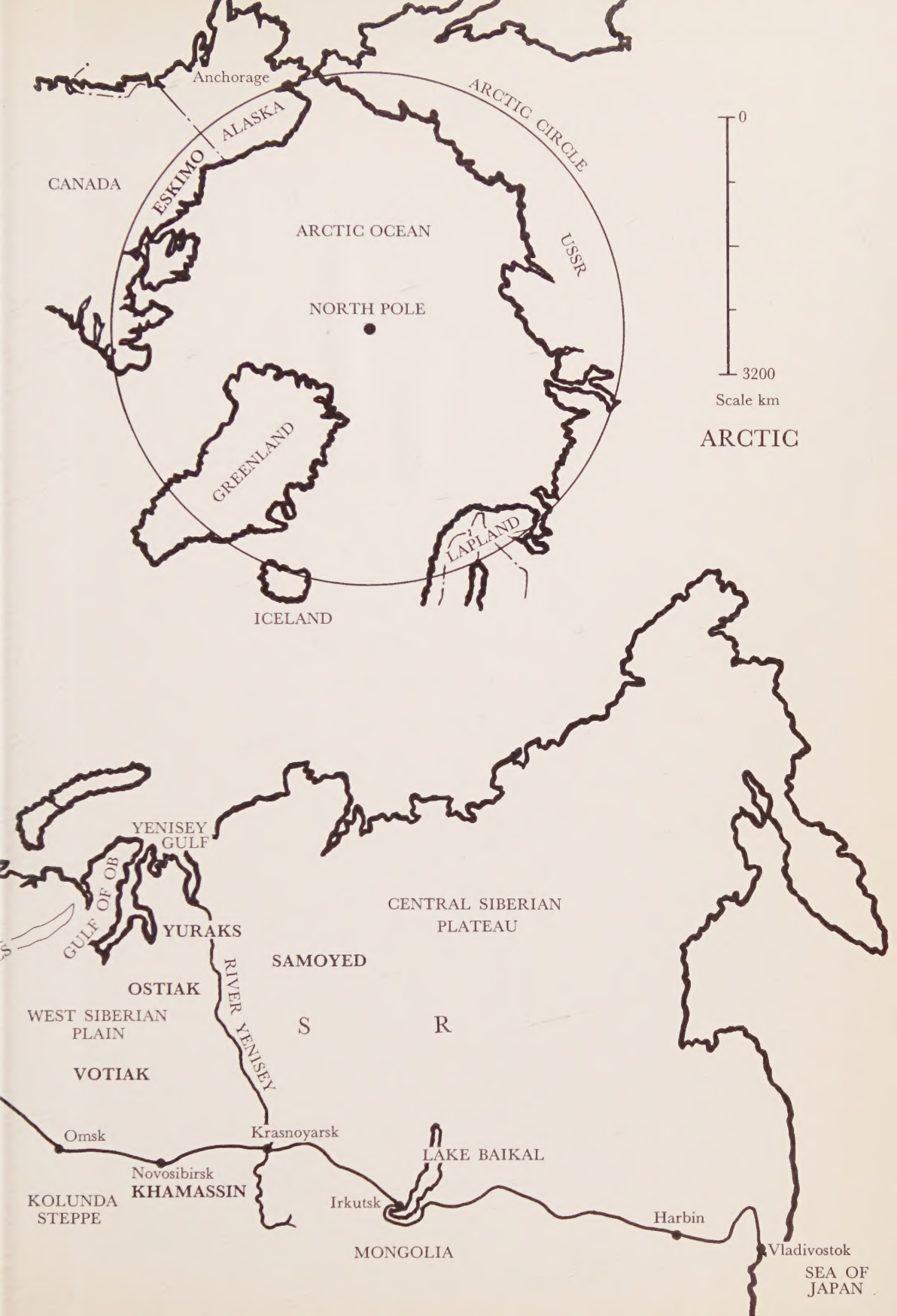
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ESKIMO
CANADA
ARCTIC CIRCLE
ARCTIC OCEAN
USSR
NORTH POLE
GREENLAND
LAPLAND
ICELAND
0
3200
Scale km
ARCTIC
YENISEY GULF
GULF OF OB
YURAKS
SAMOYED
CENTRAL SIBERIAN PLATEAU
OSTIAK
WEST SIBERIAN PLAIN
RIVER YENISEY
S
R
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